COMPRESSED AIR MAGAZINE

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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Vol. xxii. OCTOBER, 1917 No. 10.

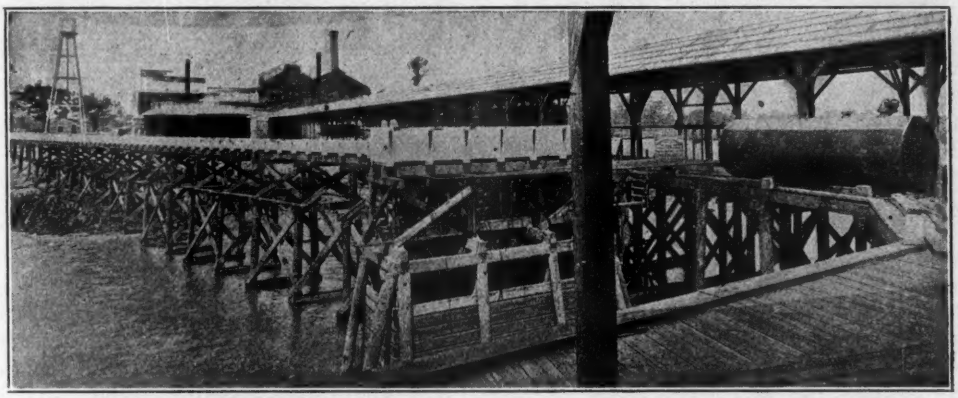


FIG. I. AIR LIFTS AT SAVANNAH SUGAR REFINERY

THE AIR LIFT RUNS SAVANNAH'S GREAT SUGAR REFINERY

A new sugar refinery at Savannah, Ga., with a capacity of 1,000,000 pounds of sugar a day, has been built in record time by Westinghouse, Churck, Kerr & Company, for the Savannah Sugar Refining Corporation. It is located on the bank of the river about 8 miles above the city with docks at which its cargoes of raw sugar are received direct from Cuba.

Savannah is now regarding this plant as its greatest industrial asset, not only for its own intrinsic value to the city, but for its attracting to the same location of many other important industrial installations, with the accommodations for a large population of workers who must live in the vicinity.

The enterprise is written up in a complete and interesting manner in a recent issue of the *Manufacturers' Record,* of Baltimore, from whose pages our illustrations are reproduced. We can give our attention to only one feature of the plant, which is its effective provision for an adequate and reliable water supply. The requirement was for 10,000,000 gallons per day, a volume equal to the entire normal consumption of the city of Savannah. As the water was to be pumped from the river steam pumps would naturally first be thought of, but as the main power house was 2,000 feet from the river the distance would be too great for steam piping, and it would have been necessary to install a separate boiler plant near the pumps.

It was, however, perfectly feasible to transmit compressed air the required distance, and accordingly air lifts of the Ingersoll-Rand type were installed with an Imperial compressor in the power house to supply the air, and a pipe line from there to the wells.

Fig. 1 shows the essential features of the air lift installation, the view being taken from the sugar dock where the cargoes are received. In the middle foreground is a permanent cofferdam enclosure in which the six independent lifts are located. For each of the lifts a 16 in. pipe was sunk to a depth of 70 feet. The pipe when sunk to the required

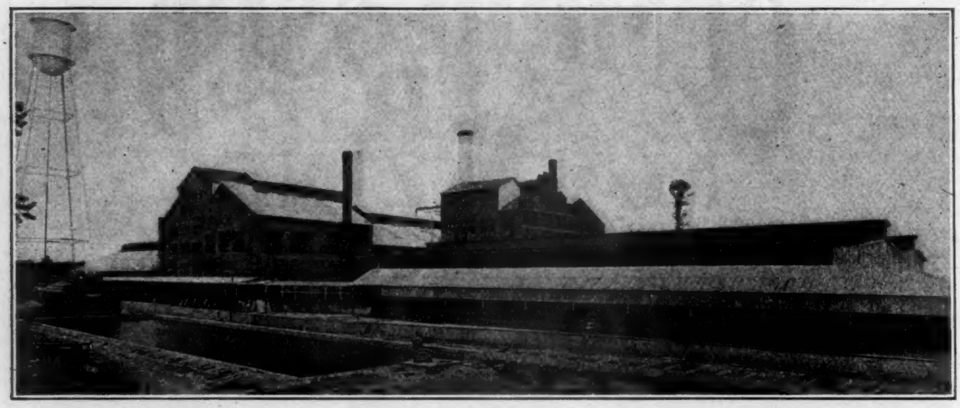


FIG. 2. FLUME AND FILTER RESERVOIRS

depth was cleared of sand and the bottom was plugged tight with a body of concrete. This then constituted a well always full of water flowing in from the bed of the river at the top of the well. Into each well was then placed and securely supported a 9 in. water delivery pipe with a foot-piece extending nearly to the bottom of the well. A 2 in. air pipe carries the air down the well, where it enters the water delivery pipe and the bubbles of air are distributed through the column of water all the way to the top thus levitating the column of water so that it continuously rises and flows away into the flume and is continuously displaced by the "solid" water of the well flowing in at the bottom. The flow continues night and day as long as the supply of air is maintained. At the right of the picture is a large air receiver to equalize slight fluctuations of air pressure. At the left end of the receiver is seen the main air pipe with the vertical pipes leading to the several wells. In each of these pipes is seen a 2 in. stop valve for controlling the flow of air or for shutting off either well, when, as is generally the case, all are not required. The flume into which the water is delivered, 12 ft. above the surface of the river, is seen extending to the extreme left of the picture, and in Fig. 2 is seen the end of the flume and one of the settling tanks into which the water is delivered.

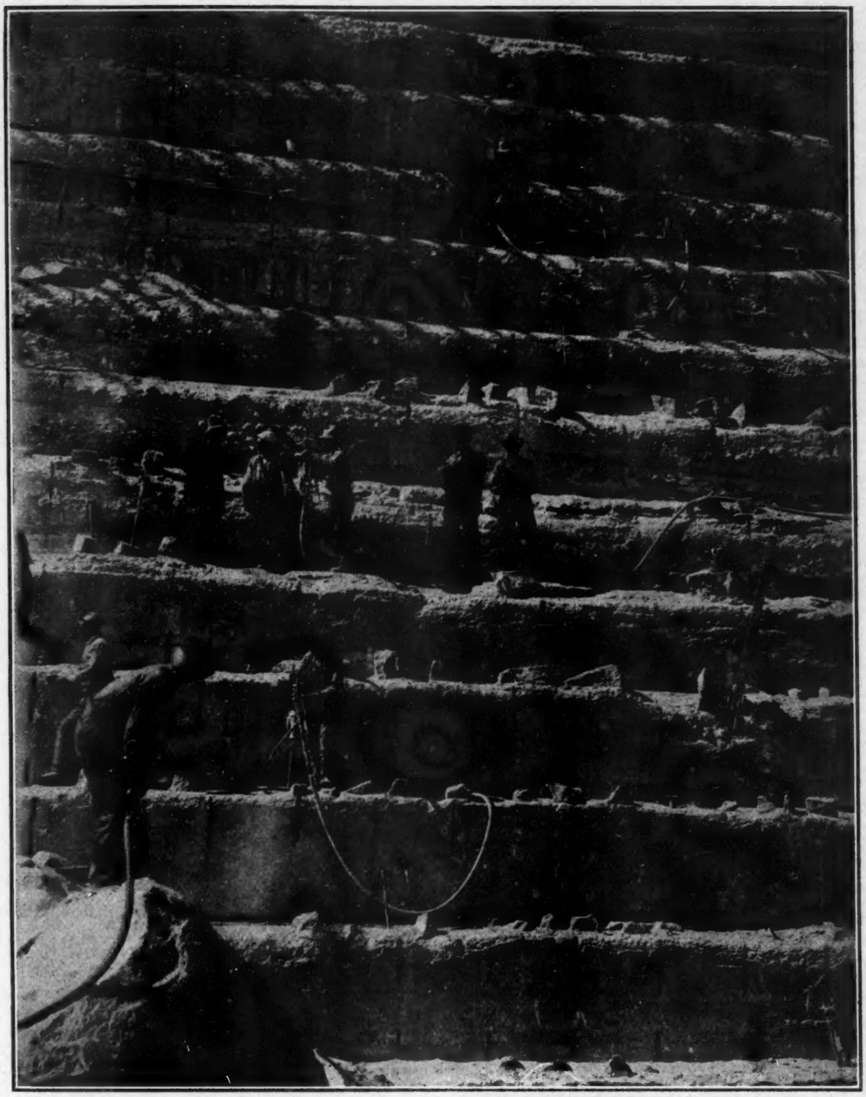
Here the water is chemically treated to cause the settling of mud and silt, and is then pumped by steam pumps to sand filters on top of the refinery buildings. Coming out of these clear and pure it is heated and converted into vapor for the vacuum pans, and is used in large quantities for washing the boneblack through which the sugar is filtered. The water also is used for the battery of 13 steam boilers.

It will readily be seen that the air compressor which animates the air lifts is thus the heart which supplies continuous impulse to the entire establishment. It is not a formidable affair and is little suggestive of the responsibility it bears. It is an Imperial X Duplex Steam Driven Compressor with steam cylinders 12 in. diameter, air cylinders 21 in. diameter and a stroke of 16 in. It runs normally at 170 revolutions per minute, with a piston displacement or nominal free air capacity of 2171 cu. ft. per minute, at 30 lb. gage pressure.

Under the direction of Mr. O. L. Merkt, engineer in charge, the air lift system was tried one day in June and turned out within the time more than the 10,000,000 gallons of water required.

In addition to the air lift above described the engineers also sunk an artesian well 550 feet deep, with an air lift flow of 400 gallons a minute. This artesian water, which is too "hard" for boilers and vacuum pans, is used for washing the refined sugar and for drinking purposes.

The railroad connecting Chili and Bolivia, which crosses the Andes 14,105 feet above sea level, provides oxygen chambers in which passengers can get relief from the rarefied air of the high altitudes.



DRILLING FIVE-INCH HOLES FOR DAM REINFORCEMENT

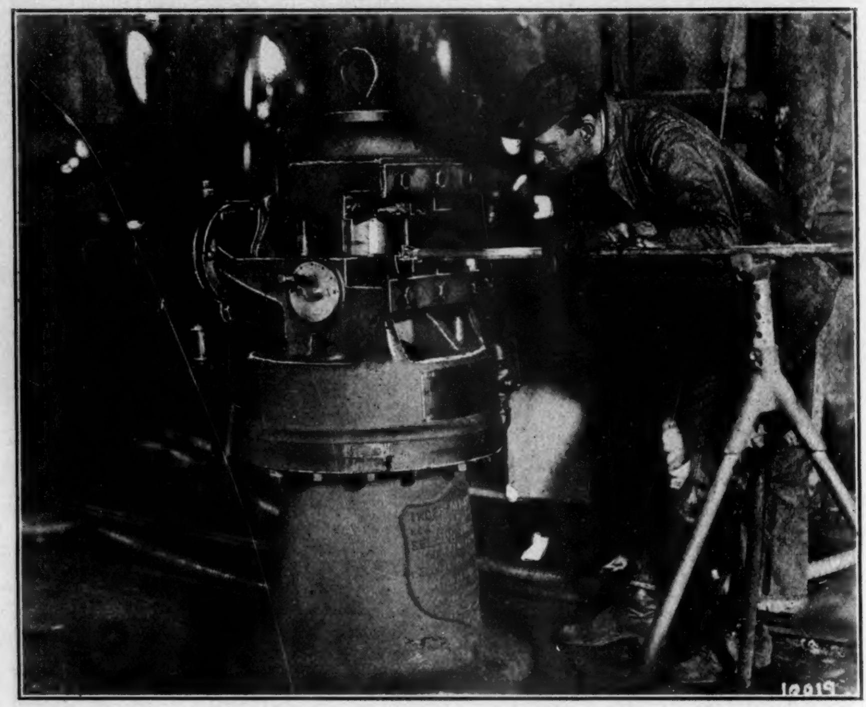
FIVE-INCH HOLES MADE WITH HAMMER DRILLS

BY H. L. HICKS

The reconstruction and enlargement of three dams at Big Creek, Fresno county, California, to provide additional storage capacity is marked by a method of anchoring the new concrete to the original reinforced-concrete structure of dam 2, which required drilling a large number of shallow, large-diameter holes.

The construction work is being conducted by the northern division of the Southern California Edison Co., whose chief engineer, R. C. Starr, devised a plan of using 6-ft. lengths of 30-lb. rail as ties, setting them vertically into the stepped back of the existing dam. This necessitated the drilling, at close intervals, of 5-in. holes 3 ft. deep. In fact, the practical success of the whole system was dependent upon the possibility of drilling with rapidity and at reasonable cost the large number of holes required.

Owing to the unhandy location of the holes



LEYNER DRILL SHARPENER AT BIG CREEK DAM

to be drilled, it was out of the question to use the heavy tripod-mounted piston drills usually employed for putting down large-diameter holes. E. L. Fox, superintendent in charge of the drilling, placed his faith in the ability of unmounted hammer drills to carry out the work, although nearly all the drill manufacturers were of the opinion that it would not be possible to handle bits as large as 5 in. in diameter because of the large number of very hard boulders which would be encountered embedded in the concrete. After experimenting with various kinds of bits and different machines, Mr. Fox finally selectel Leyner-Ingersoll drills for this heavy duty, they having shown from 30 to 40% greater speed than others.

Eight drills are in use, of the type ordinarily used in tunnel driving on a column or bar mounting. The drills have been fitted for this work with special handles and are operated by two men as hand hammer drills. Standard 1¼-in. solid round steel is used with 5-in. bits. The Leyner water-feeding device has been dispensed with and the holes are drilled dry, the cuttings being cleaned out by means of an auxiliary blowpipe. The average drilling time for a 3-ft. hole is 20 minutes.

The duty on the drills is severe, and to re lieve the strain as much as possible a Leyner sharpener (Fig. 2) fitted with special dies to handle the large bits, was installed. Absolute gage perfection secured in this way relieves the drill rotation mechanism of excessive wear and has largely eliminated loss of time due to stuck steels.

When all the holes have been drilled the lengths of rail will be grouted in and the forms set for pouring the new concrete.—*Engineering News Record.*

HOW IT FEELS TO BE GASSED

BY AN ENGLISH OFFICER

"It was somewhat over a year ago that we put up four mines right under the enemy's front line. I was not in the line that night, as I had been relieved three days before, but the officers not on shift all went up to high ground a mile or so behind, and saw them go up. The drives were all in clay, and not a stick of timber put in to support either roofs or sides; 4 ft. high and 2 ft. wide, regular

'rabbitburrows,' as we call them, and we 'rushed' them at the rate of 30 ft. a day, an eight-hour shift doing 10 ft. Of course, all the dirt had to be carried out in sand bags, and put over the parapet at night. The Infantry in our lines carried out a bombing raid, but the damage done was so great that they only got three prisoners. All the enemy in the front line of that section at the time seemed to have been killed, and the trenches absolutely obliterated, so it was quite a successful 'stunt.' The prisoners say that there were over 150 men in these trenches at the time of the explosion. In one of our saps we broke into a German sap which they were working. We had interpreters down to listen to what they were saying, and one afternoon one of them came down and shouted: 'Where are you, Hans?' first in German and then in English. It rather frightened our men, till we found that they both spoke English.

"Now after an affair like that, one may expect reprisals. I reached the shaft, and met an Infantry officer who had had a look in, hearing my fellows moaning, and he and his sergeant were gassed on the first step. I posted a sentry, with orders on no account to let any one down until my return, and hurried off to get my mine rescue apparatus. The mine rescue station is about 250 yards away. I put on my set, and took the man who was in charge of the proto station (a trained man) with me; also a rope. Adjusted my gear when I reached shaft head; told the Infantry to haul when I pulled three times on the rope. The first man was in about 100 ft. I hitched the rope round him, and pulled three times. I put my hands under the man's head, to keep him from being hurt. Well, they hauled him hand over hand like a sack of coals, and I, having a proto set weighing 35 lb. on, and holding up his head and shoulders, was simply dripping with perspiration when I got to the top. I told them to go on with artificial respiration, send for an oxygen reviving set, and keep him warm. I reached No. 2, and the Infantry hauled him out carefully and slowly. No. 3 was my corporal, a great big chap with a bad cut on the head as well as gassed. But he was breathing, though 'out,' and two others were in the same condition. By this time I had used up all the oxygen in one proto set. On reaching the surface I found that three good proto men had arrived, also my Captain and another Lieutenant. We dug our man out, and I ran up to the shaft head and told them to haul when I pulled three times. We put him on to the mat and roped him in, and pulled three times, but they had got mixed up somehow, and would not start the winch; so, as I had three good proto men standing alongside me, I took the risk and pulled my mouthpiece out for just enough time to shout: 'Haul, you fools, can't you?' Directly I'd done this, I regretted it. However, they hauled, and as soon as the dead man was clear of the shaft, I sent my three men up, and followed them myself. I should have liked to have the rope down for me, but could not signal to tell them. Every rung of that ladder seemed to get bigger and bigger, till it seemed like getting my hands round a small tree, and my arms had gone stiff, so that I could not bend them at the elbow; but I got there all right, and was collared by the men at the winch as I reached the top and was just dropping off. When I got to the top of the incline I pulled myself together, and told my Captain that all the other men (six) must have been instantly killed by the shock and the fall of earth, and that it would be of no use to send any one down again till the CO gas had cleared. I got to our bottom dugout about 400 yards away somehow—with assistance. It was then dark, and I had been under since 5.15 p. m. As it was June, it would, I fancy, be nearly 10 p. m. I had enough sense to tell them to put an oxygen reviving set on my mouth, and I remember very little more till I got to the first Field Dressing Station, about a quarter or half a mile up the trench. Here I was given hot coffee, which made me very sick, and infernal smelling things were put in front of my nose. When I had more or less revived, I was taken on up the trenches. I found here the men who had been gassed, all doing well and able to speak, and they started up the trench on stretchers with me. I shall always remember that last stretch of trenches, for it was raining hard and I was so cold, and shaking with ague. CO absolutely stops one's circulation for the time; I was also very sick. So on to No. 2 Dressing Station, that is where the motor ambulances pick you up. Here my Company doctor met me, and it seemed better for me to go to the 'Savoy,'

which was only 300 yards away from the top dressing station, and get warmed up with hot water bottles. So our doctor took me along in the stretcher, got my clothes off himself, and dumped me from the stretcher on to the bed without any mercy, and put two rum jars of hot water along with me. By this time it was half-past two in the morning. I slept more or less till seven, and woke up feeling quite fit.

INDUSTRIAL OXYGEN EXPLOSIONS

In the issue of COMPRESSED AIR MAGAZINE for May, 1917, attention was called to the occurrence in California the year before of three fatal explosions of oxygen tanks within three days of each other, the cause of the explosions being the pressure of hydrogen in the tanks commingled with the oxygen. Many serious explosions from the same cause have been occurring in different parts of the country leading to various investigations. Mr. Edward K. Hammond, Associate editor of *Machinery,* has done the industrial community a valuable service in compiling up-to-date information upon this important topic, and his article is here substantially reproduced.

TWO METHODS OF OXYGEN PRODUCTION

Attention is first called to the fact that commercial oxygen is produced by two quite different processes. The first is generally known as the liquid air method, which consists of liquifying air by the application of pressure and reducing the temperature, and then separating the oxygen from the nitrogen by taking advantage of the difference in boiling points of the two liquids. Oxygen produced in this way cannot explode through the presence of impurities, because these impurities are nitrogen and other gases which are chemically inert. The second method of obtaining oxygen is by the electrolysis of water, and here there is a possibility of accidents due to hydrogen being present in sufficient quantity to make a mixture that is highly explosive. This danger is theoretical rather than practical, so long as the proper precautions are taken in the operation of electrolytic generating plants; but where there is lack of care in attending to generators or where the generators are of unsuitable design, this danger may prove serious.

RANGE OF PROPORTIONS OF EXPLOSIVE MIXTURES

Theoretically, the explosion of a mixture of hydrogen and oxygen results in the combination of two volumes of hydrogen gas with one volume of oxygen; but while this is the mixture required for a complete explosion, experience has shown that there is a wide range of mixtures that constitute what may be called a danger zone, *i. e.,* mixtures that may explode with violence under certain conditions. This question was considered of sufficient importance to warrant an investigation being undertaken at the Pittsburg Laboratory of the Bureau of Mines, where it was found that mixtures ranging from 9 per cent, of hydrogen and 91 per cent. of oxygen up to 92 per cent. of hydrogen, and 8 per cent. of oxygen were likely to give trouble. This is more liberal than limits established by the Davis-Bournonville Co., Jersey City, N. J., a well-known manufacturer of welding and cutting equipments, including oxygen generators. In this company's laboratories the danger zone was found to cover a wider range, extending from 6 per cent. of hydrogen and 94 per cent. of oxygen down to 97 per cent. of hydrogen and 3 per cent. of oxygen. The idea of this danger zone will be best understood by reference to the tabulated figures, the brackets representing the range of explosive mixtures. Here

Oxygen	Hydrogen
100	0
98	2
96	4
94	6
91	9
8	92
6	94
3	97
2	98
0	100

Note—Brackets inside the columns represent range of explosive mixtures, as determined by Bureau of Mines; and brackets outside the columns cover range of mixtures found to be explosive by the Davis-Bournonville Co.

it will be evident that mixtures of hydrogen and oxygen represented by the high and low limits, and all mixtures coming between these limits, may be made to explode under suitable conditions.

CHANGES IN ELECTROLYTIC GENERATORS

Investigations conducted with the view of determining the cause of oxygen explosions that have resulted disastrously have led to certain important modifications in the design of electrolytic generators and auxiliary equipments to prevent the recurrence of such acci-

dents. In the operation of an electrolytic cell, decomposition of water results in liberation of hydrogen at the negative electrode of the cell, while oxygen passes off from the positive electrode. The cells are so arranged that gas collected from each of these electrodes is passed into containers provided for the hydrogen and oxygen, respectively. Should it happen that the polarity of the generator is reversed, it would result in a corresponding reversal of the polarity of the cells, so that oxygen would be collected in the container provided for hydrogen, and *vice versa.*

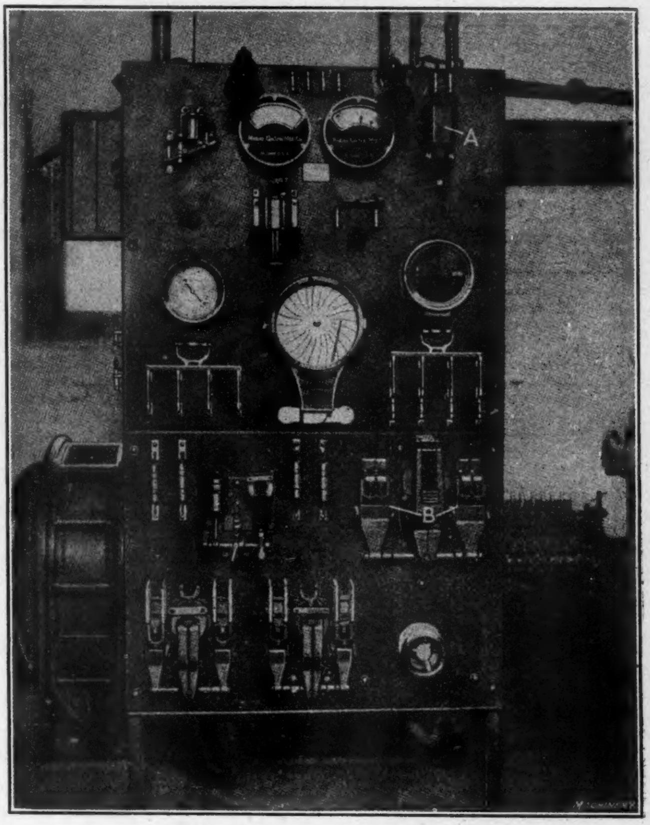


FIG. I. SWITCHBOARD WITH AUTOMATIC SWITCH TO PREVENT REVERSAL OF POLARITY

As a matter of fact, this has been the cause of some serious accidents, and a study of the subject led to the provision of safety devices which make it impossible for trouble of this kind to occur. The safeguard consists of an automatic switch, which makes connection with the electrolytic cells only after the generator has reached normal speed and is developing its normal electromotive force. The necessity for this provision arises from the fact that at any time when the operation of a generator is stopped there is a tendency, while the armature is still turning over by inertia, for a counter-electromotive force to be built up in the cells. This may reach sufficient proportions to overcome the magnetic force of the field windings of the generator, so that when it is again started the generator will operate with its polarity the reverse of normal and supply energy of a correspondingly reversed polarity to the electrolyzers.

Should such a condition exist, it is obvious that hydrogen would be delivered to the oxygen gas-holder and oxygen to the hydrogen gas-holder, thus forming a dangerous mixture with the gas already in these holders. But with the automatic swtich referred to, there is no danger of this trouble, because the generator will have assumed a normal speed and developed its normal electromotive force before the switch can be closed to allow current to pass through the cells. This method of safeguarding the connecting of the electrolyzers to the power supply makes it impossible for a counter-electromotive force in the cells to overcome residual magnetism in the windings of the generator. In the switchboard illustrated in Fig. 1, the switch shown at *A* is for making connection between the generator and cells, and is automatically closed by magnetic coils *B* when the generator speed and voltage have reached the normal figure. When the electric generator is stopped, the circuit through the electrolytic cells is automatically broken.

To further assure against trouble from a counter-electromotive force in the electrolytic cells due to causes outside the plant,

such as the reversal of phase in the motor supply circuit, transposition of connections at the electrolytic cells, etc., use is made of a polarized relay connected to a special shunt. This provides for opening a single-pole relay in the control circuit, and the only way in which this circuit may be re-established is to close the relay by hand, provided the polarity has been restored to normal. If a plant is equipped with this system of control, reversal of polarity is indicated by failure of the electrolytic cells to operate. It is important to note that the generator used in connection with electrolytic cells should be of the shunt-wound type, because with compound-wound generators there is greater danger of reversal due to the counter-electromotive force in the cells passing through the series turns.

In addition to danger of the generation of explosive mixtures of oxygen and hydrogen through a reversal of polarity of the generator, trouble may also be experienced through improper connection of the terminals of electrolytic cells. As a matter of fact, this was the cause of a serious explosion which occurred in St. Louis some time ago. With the view of preventing accidents of this kind, the Davis-Bournonville Co. and other manufacturers of electrolytic cells have designed their electrical connections in such a way that it is impossible to connect them with the wrong polarity.

FREQUENT CHEMICAL ANALYSIS

There is only one way to be sure that the purity of oxygen generated in electrolytic cells is up to the required standard, and that is by making chemical analyses at intervals of at least two hours. As a matter of fact, these analyses are simple to make and do not call for extensive technical knowledge of chemistry. Several methods are employed, the most common one being that of measuring one hundred cubic centimeters of gas into a burette, and then running this gas into another burette in which the hydrogen is burnt out by a platinum coil, which is raised to a red heat. The gas is then returned to the first burette and again measured, the contraction in volume expressed in cubic centimeters representing the percentage of hydrogen in the gas.

Other methods of determining the purity of oxygen consist of running the measured volume of gas into a second burette containing either pure metallic copper or sticks of phosphorous. Both these materials have the power to absorb oxygen from the mixture of oxygen and hydrogen, and after this absorption has been completed, the hydrogen is returned to the burette and measured. The contraction in this case represents the percentage of oxygen present. Standard apparatus can be purchased for making all these tests. In practice, it is customary to get a purity of 99.7 to 99.8 per cent. for hydrogen and a purity of about 99.5 per cent for oxygen. If the purity of hydrogen runs below 99.5 per cent. or the purity of oxygen is found to be below 99 per cent., it is considered that the generator is operating unsatisfactorily, and the man in charge of the station immediately proceeds to look for the cause. Where this precaution is taken, there is little danger of trouble from the use of electrolytic oxygen, because a high factor of safety is provided.

OIL CAUSING EXPLOSIONS

Experience has shown that in the presence of oil there is danger of an oxygen cylinder "exploding" from what may properly be termed "spontaneous combustion" of the cylinder, although the gas is pure oxygen without any trace of hydrogen. This is due to the fact that the action of oxygen under high pressure—usually about 1,800 pounds per square inch—results in oxidation of the oil, thus raising the temperature sufficiently to start the oxygen acting upon the iron cylinder, which is burnt away and allows the high-pressure gas to expand rapidly. This could not properly be called an explosion, because an explosion is usually understood to mean rapid combustion accompanied by rapid expansion. However, the condition that exists when the high-pressure oxygen is allowed to expand suddenly is similar to a true explosion, and the results have been serious in some cases. In this connection it is of interest to note that oxygen produced by the liquid air process and oxygen generated in electrolytic cells are equally likely to give trouble. Recently, the statement was made that this source of trouble could be eliminated by substituting graphite as a lubricant in place of oil, but experiments conducted by the International Oxygen Co., the Davis-Buronville Co., and others show that graphite is just as dangerous as oil.

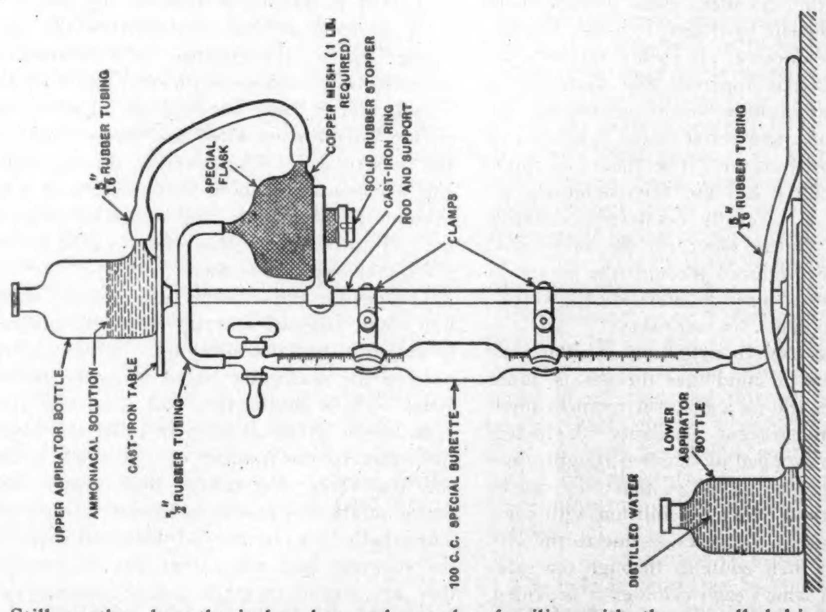


FIG. 2. FOR DETERMINING PURITY OF OXYGEN BY ABSORPTION WITH METALLIC COPPER

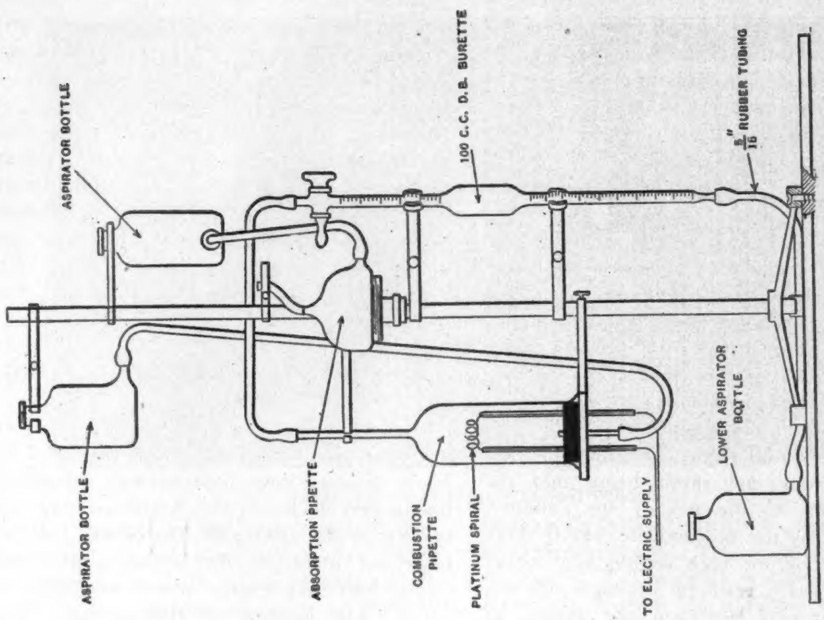


FIG. 3. FOR DETERMINING PERCENTAGE OF HYDROGEN BY COMBUSTION METHOD, AND PERCENTAGE OF OXYGEN BY ABSORPTION WITH METALLIC COPPER OR STICKS OF PHOSPHORUS

Still another hypothesis has been advanced as to a source of danger from the explosion of hydrogen. Reference has already been made to the fact that experimental data show that there must be at least 6 per cent. of hydrogen in the oxygen to make the mixture explosive. This refers to 6 per cent. of hydrogen uniformly mixed through the entire volume of oxygen. Readers of *Machinery* are doubtless familiar with the so-called kinetic theory of gases, otherwise known as the theory of uniform diffusion. According to this theory, the constituents of mixed gases are kept uniformly distributed, due to the kinetic action of molecules of the gas. For instance, a mixture of hydrogen and oxygen containing 3 per cent. of hydrogen would have the hydrogen uniformly mixed through the 97 per cent. of

oxygen, and as it has already been mentioned that a minimum of 6 per cent. of hydrogen is required to make the mixture explosive, it will be apparent that there would be no danger with this gas under normal conditions.

STRATIFICATION OF THE GASES

In practice, accidents have occurred through the explosion of oxygen cylinders in which the head has been blown out of the cylinder, and investigations conducted to determine the cause of these accidents have led to the belief that under the high pressure which exists in an oxygen cylinder—amounting to approximately 1,800 pounds per square inch—the theory of uniform diffusion is not effective; it is assumed that under these conditions of pressure the gases settle out into strata, according to their specific gravities, the result being that the hydrogen rises to the top of the cylinder. This action may not be complete, but if there were a tendency for such settling out to occur, it could easily result in producing an explosive mixture of hydrogen and oxygen at the top of the cylinder, even though there were not sufficient hydrogen to make the entire mixture explosive. If such conditions can be developed, it is apparent that flashback or other cause of ignition would immediately ignite the mixture and result in the explosion of the gas in the cylinder. The theory is interesting, although it has not been definitely established by a carefully conducted scientific experiment. An accident of the same kind might also be produced through the action of oxygen on the oil used to lubricate the valve.

CAUTION IN HANDLING

In handling oxygen cylinders, it should always be borne in mind that the gas is under high pressure, and as a result it requires intelligent care to prevent accidents. Cylinders should not be dropped or handled roughly, and they should not be placed so that they can be easily overturned either by collision with some other object or by the reaction due to the violent escape of their contents through the safety outlet with which each cylinder is provided. The valve regulating devices and other attachments should not be lubricated with oil for reasons to which reference has already been made. Discharge valves should be opened slowly and special care should be taken to avoid twisting or straining the valves by the use of hammer or improper wrenches.

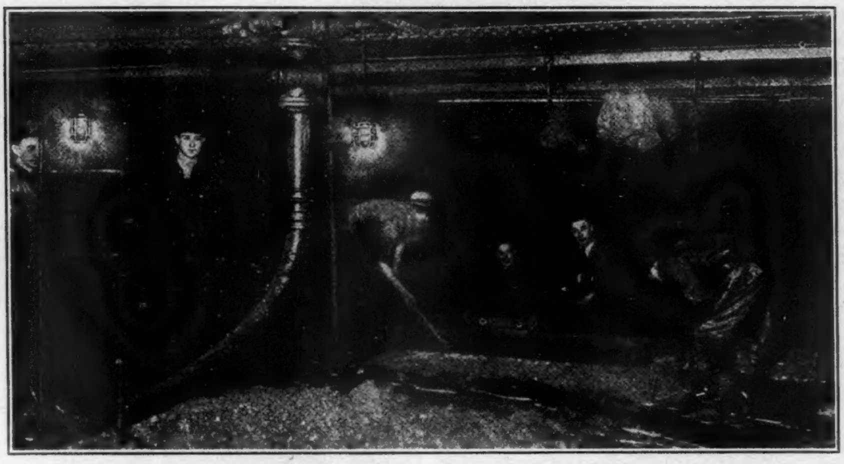
Much valuable information has been gathered by members of the Committee on Production of Electrolytic Oxygen and Hydrogen which has been appointed by the Compressed Gas Manufacturers' Association, Inc., 120 Broadway, New York City, concerning possible dangers, connected with the use of oxygen in the operation of cutting and welding torches. Distribution of information concerning the proper way to use oxygen and the safeguards that should be taken to avoid accidents will doubtless be the means of overcoming much trouble from this source.

RESPONSIBLE WORK OF A DIVING BELL

One of the great engineering works of the day, the new steamship docks at Halifax, Nova Scotia, now approaching completion, the largest docks on the American continent, costing in the aggregate $30,000,000, has perhaps not attracted the attention its magnitude and importance would seem to demand. The location of Halifax as a shipping port is unique, in that by the use of it as a point of arrival or departure the open voyage across the Atlantic is shortened by several days, varying with the speed of the vessel, and it thus becomes of supreme importance in the crowded and risky traffic of the present war. The docks in the aggregate can accommodate about fifty vessels of 7,500 tons at the same time, and two such ships as the Olympic and the Mauretania could lie end to end at one of the piers.

The design and construction of these docks had their original features carefully planned to suit the special conditions. The piers supporting the docks are based upon the underlying rock of the harbor, and consist of concrete shells 31 by 21 by 3 ft. piled one above the other to the number of 13, which brings the top three feet above high water, and surmounting this blocks of granite are placed. The shells are reinforced by steel bars in the making, and when they are in position they are locked together and the interiors of the shells are filled with concrete, also reinforced, thus forming a solid and enduring mass.

A genuine diving bell, not differing essentially from the old familiar type, is employed in clearing the surface of the rock and preparing upon it a level bed of concrete for the reception of the shells spoken of above.



WORKING CHAMBER OF DIVING BELL

The area covered by the diving bell or movable caisson is somewhat larger than the dimensions of the shells to be placed, and the height of the working chamber is sufficient to permit perfect freedom of movement. A view of the interior of this chamber with work going on is given in the halftone here reproduced from the *Scientific American*. As the face of the rock averages about 40 ft. below the water level the air pressure carried, varying with the height of the tide, has been about 20 lb. per sq. in., not enough to cause serious trouble to the workers. The diving bell is lifted and shifted from one location to another by a powerful derrick. With the diving bell not lifted out of the water, and with any desired amount of air in the chamber not much power is required for moving it.

An immense railroad area is provided for both passenger and freight service at the pier level. Although the docks are not to be completed until next year great docking facilities for both Canada and the United States are already available.

HAND-DUG OIL WELLS IN JAPAN

One who visits Higashiyama for the first time is bound to be struck with a sight which is strangely incongruous. As he ascends by a trail toward the crest of Katsubo hill, which presents a typical appearance of an up-to-date oil field, with rigs, tanks and boiler houses, he will see the flank right below the crest scattered with conical structures, closely resembling Indian tepees. These are huts built over dug wells. Existence of this primitive type of oil well in close proximity to the modern method of operation is mainly due to scarcity of fuel and absence of water sand above the pay. The well is dug by a man descending to the bottom, the chief tools being a pick and a mattock. The earth or rock dug up is hoisted out of the hole in rope nets by means of a straw rope that passes over a wooden pulley hung from a beam stretched across the hut about 10 feet above the mouth of the well The rope is pulled by three men, two standing on a shelf built in the hole about a couple of feet below the mouth.

The hole is 4 or 5 feet square and goes down 400 or 500 feet to the sand without any variation in size. The sides of the hole are timbered all the way through by driving a post in each corner to which are mortised girts to keep sheathing boards against the well. The girts also serve the purpose of a ladder for the digger in going down to the bottom.

A PRIMITIVE BLOWER

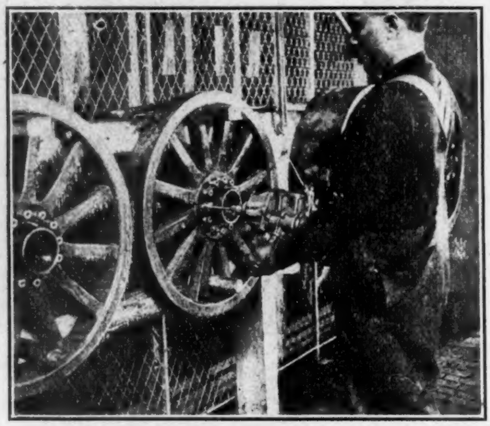
The hole is ventilated by constantly sending down fresh air to the bottom by means of a treadle-bellows, which is a sort of bottomless box of oblong shape, measuring about 7 feet long by 3 feet wide and 2 deep, set on the ground at one side of the mouth of the well. The box is divided into two compartments by a board set in the middle of each longer side of the box. There is a rid or tread-board that

covers the entire top of the box, snugly fitting within four sides, and balancing on the top of the dividing board which swings in see-saw fashion. A man stands on the board and walks from from one end of it to the other, alternately kicking down first one end and then the other. In each end of the board is a valve consisting of a square hole with hinged flap underneath, and when one end is kicked down the valve on the end closes up and forces the air in the compartment at that side out into a small chamber, attached to the outside of the box, inside of which there is a tongue valve that cuts off the communication with the other compartment and allows the air to rush down into an airshaft, which extends from the bottom of the chamber into the bottom of the well. As the depth of the hole increases more men are set to working the bellows, and as many as a half dozen men are sometimes seen treading on the board.

The diggers generally work in a tour of two hours each, and when the hole is making some gas or oil, the man in the bottom gets so exhausted a tthe end of the tour that he is literally dragged out by a rope that is tied to the life belt which he wears, on which occasion his life hangs on the rope and a wooden pin scarcely larger than a lead pencil which holds the sheave in the pulley over which the rope is pulled. It is strange to note that no accident has ever happened from the breaking of either the rope or the pin.

PNEUMATIC TIRES BEST

Truck manufacturers and users generally advocate the use of solid rubber tires, but evidence shows that the pneumatic tire, properly proportioned to the load, is as advantageous for trucks as for pleasure motor vehicles. The test on a Packard 1½-ton army transport truck was recently made over a distance of 4288 miles from Detroit, Mich., to the Mexican border and back. The truck was fitted with 36- by 7-inch "Nobby" tread U. S. pneumatic tires. The conclusions drawn from the trip are that an average of 40 per cent. more mileage per gallon of gasoline can be obtained from trucks equipped with pneumatic tires than from those equipped with solid tires, and that oil consumption is reduced 25 to 30 per cent. The pneumatic tires greatly reduce road shock and lower truck depreciation fully 50 per cent. The average mileage per gallon of gasoline was seven, and the lubricating oil consumption of the trip was one quart of oil per 33.42 miles.

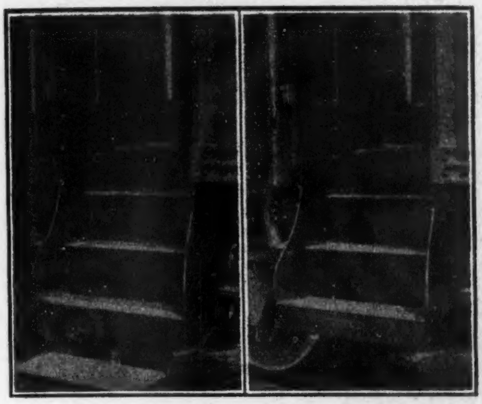


SPINNING THE NUTS ON

LITTLE DAVID QUICKER THAN MAN'S FINGERS

In modern manufacturing methods every detail of manipulation is studied with a view to quickening and cheapening the operation. The little half-tone above neatly tells a story of time saving in one simple and familiar but numerously repeated job. At the Plainfield, N. J., plant of the International Motor Company a Little David Pneumatic Drill supersedes handwork for running down and tightening the nuts on the hubs of motor truck wheels, thereby cutting down the time of assembling from 15 minutes to 2 minutes and dispensing with the services of one man of the five originally constituting the gang.

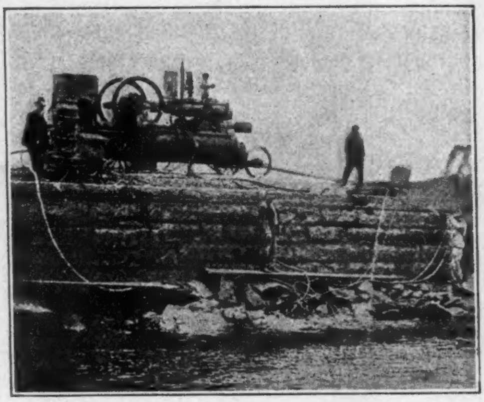
The wheels are assembled on a special bench and hung up on the three pegs here shown. One man places the nuts on and runs them down with the air drill which is provided with a special socket for the nuts, the momentum of the drill giving the necessary force for the final tightening. The weight of the drill is carried by a very flexible coil spring about 7 feet long attached to the ceiling something as bird cages are frequently hung. The length and flexibility of the spring permits the movement of the drill from one wheel to another, and as each wheel is finished the other man changes it while the men with the drill moves from wheel to wheel without interruption.



SAFETY STEP FOR RAILROAD CARS

The little halftone shows, in both positions, a pneumatically operated supplementary lower step for railroad passenger cars now being introduced by the Blake Car Step Works, Charlotte, N. C. It is intended to render unnecessary the little stool usually handled by the car porter. Advantages claimed for it are that it cannot be lowered until the car is at a standstill, and that it will return automatically to the raised position when the car starts.

When the train comes to a complete stop the conductor or porter on the train presses a foot lever or button, thus applying the air pressure to an operating cylinder which forces the step into the lower or alighting position. At the same time air is admitted to a smaller cylinder which forces a small cam down on tcp of the car axle. As long as the car remains at rest the step is held in the alighting position by the air pressure, but when the axle of the car turns the little cam on top of the axle is rolled off. This automatically releases the air pressure which holds the step, and the latter under the influence of a counterweight is carried back to its upper position where it is housed under the first stationary step of the car. The air pressure can also be released by the conductor by pressing a release lever in the housing of the trapdoor, and the closing of the trapdoor will accomplish the same purpose. The novel feature of the device is that it is not really left to an employee to put the step up before the train starts, as the automatic release on the axle cannot fail to take care of the step when the car moves. As the step is returned to its raised position by a counter-weight, it will not operate if the passenger has his weight on it. This avoids throwing a passenger who is trying to alight when the step starts to rise.



SEAWALL AT GOVERNOR'S ISLAND

WHAT ONLY THE CEMENT GUN COULD DO

In the seawall of Governor's Island, in New York harbor, there were many thousand feet of joints between the stones from which the mortar had disappeared, leaving open seams 1 to 1½ in. wide and from 3 in. to 3 ft. deep, and for the safety of the wall it was very necessary that the mortar or its equivalent should be replaced. Hand work could not be relied upon for placing mortar to depths exceeding 6 in., and accordingly the cement gun was employed.

The outfit, seen in the picture, comprised, besides the gun, a portable gasoline driven compressor, on which was mounted also a Gould pyramid pump. The entire gang employed comprised a compressor runner, a gunman, five to seven laborers, a horse and cart and an overseer. The rig, in 25 working days, filled 22,320 feet of joint, or 900 ft. per day, at a total cost of $2,913, or a trifle over 13 ct. per foot. Henry N. Babcock, U. S. Assistant Engineer, in Professional Memoirs," estimates this cost to have been 10 to 15 per cent. greater than it would have been in a more accessible location.

It is estimated that the average depth of the joints was 12 to 15 in., and, so far as a number of tests could determine, all joints were filled to their full depth with compact and durable mortar.

COMPARATIVE TESTS OF HAMMER DRILL BITS

An investigation has recently been made by Prof. Carroll R. Forbes and Joseph C. Barton to determine the effect of the shape of the cutting edge on the cutting speed and wearing qualities of drill bits, the results of the tests being given by them in a paper for the October meeting of the American Institute of Mining Engineers, printed in the Transactions of the Society for August, 1917. What follows is a condensation of that paper, many of the tabulated records and curves of performance being necessarily omitted.

The bits tested were those in common use, namely, the 4-point or cross bit, the 6-point bit, the Z bit and the "Carr" bit, Fig. 1. The rock in which the tests were made was the red granite from southeast Missouri. It is a coarse crystalline granite containing an unusually large amount of quartz and is extremely hard, and on account of its uniform texture is admirably adapted to this work. While tests in other rocks might show somewhat different results, nevertheless it is the opinion of the authors that the relative cutting quality inherent in the shape of the bits would be the same in all rocks. Other qualities, such as mudding freely, freedom from fitchering, etc., might make one bit more desirable that another in softer rocks.

The 4-point bits were the usual shaped bits commonly made on the Leyner sharpener with 14° taper on the wings and a 90° angle between cutting edges. Some tests were run at 85 lb. pressure with a 4-point bit made with a 5° taper on the wings. This was made by using the Carr bit die.

The 6-point bits were the usual shaped bits made on the Leyner sharpener.

The Carr bits were made with a 5° taper and an angle of 100° between cutting edges.

The Z bits were made with the regular Z-bit dolly which makes an angle of about 60° in the center and an angle of about 45° on the outer cutting edge. The center is made slightly higher than the outer edges. The Carr bit dies were used in forming Z-bits to give them a 5° taper. The Z-bit dolly was for solid steel, so it was necessary to drill out the center hole.

Several Z bits were tested at 85 lb. pressure, that were filed and hammered down, to give an angle of about 100° on the center edge and 65° on the outer edges.

The holes in the center of the bits were the ordinary size with the 4-point and 6-point and Carr bits. The hole in the Carr bit was much larger than those used in the others. A hole of the same size as in the Carr bits was used in the Z-bit.

All tests were made with an Ingersoll-Rand "Jackhamer" drill. In the "down-hole" tests the drill was weighted with a 94-lb. weight, thus insuring a constant pressure on the bit.

Most of the tests were made in vertical "up-holes." The tests consisted of drilling into a large block of granite supported on stringers over a concrete-lined pit, Fig. 2. For this work the drill was mounted on an air feed, which, however, was not large enough to produce the required pressure on the bit, so that it was necessary to counterbalance the weight of the machine by a bucket loaded with 40 lbs. of scrap iron and connected to the machine by a rope over an overhead pulley.

FIG. 1

Every effort was made to insure uniform conditions and to have the drill bit the only variable.

A uniform air pressure was obtained by having a "pop" valve on the air receiver, which was connected by a 1-in. hose to the drill. The air compressor was regulated to supply sufficient air to keep the pop valve open and the drill running at the same time, the gage pressure remaining constant. The air receiver was drained after every third steel, as it was found in former work that this factor greatly influenced the quality of the air supply.

Uniform lubrication was insured by oiling the drill after each 1-minute test. The

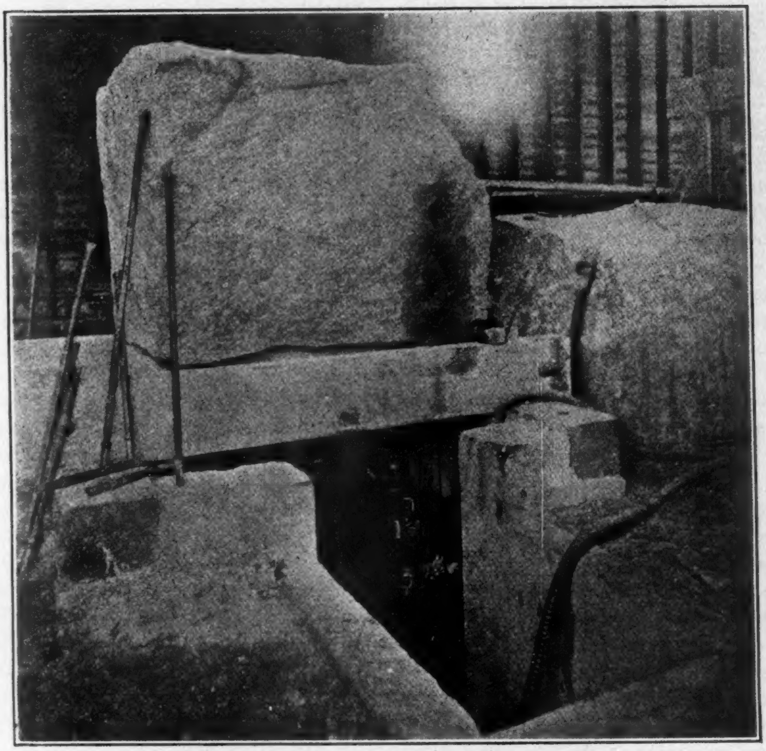


FIG. 2. WHERE THE TEST HOLES WERE DRILLED

drill was taken apart and thoroughly cleaned and oiled after every third steel.

The steel used was all of the same kind, F J A B⅞-in. hollow hexagon, and all comparative tests were run with steel of practically the same length. Lengths of 24, 48 and 62 in. were used.

MAKING AND TEMPERING THE BITS

The greatest source of error in work of this kind is in the making and tempering of bits. It is impossible to make these conditions entirely uniform and many tests were made and the results discarded, because of non-uniformity in tempering. Any bit with a corner off, or which was chipped in any way (except the Z bit in a few cases), or which showed signs of being too hard or too soft, was rejected and re-sharpened until a perfect temper was obtained.

All bits were made and sharpened in a Leyner-Ingersoll 5-A sharpener. The bits were heated, both for sharpening and tempering, in a gas muffle. In sharpening and tempering the following rules were observed: (a) Heat to the usual working heat, taking care to see that the bit is heated uniformly throughout, and making as few heats as possible. (b) Heat only the end of the bit. (c) Never submerge a bit entirely under water until cold. (d) Keep shank end square. (e) Never let scale form by too much air. (f) When worked put in lime to anneal. (g) Heat the bit up at least 800° and be sure to leave it in the furnace long enough to heat to the center; then draw from the fire and place in some dark chamber (tile, etc.), so the color can be observed, until the steel has cooled to about 800°; then dip into Sentinel paste which has melting point of 775° C., and let white residue form on the bit; place in the furnace immediately. The white residue should melt the instant the bit is inserted into the fire again; if it does not melt at once, reheat and repeat the operation.

SENTINEL PASTE

The Sentinel paste is a trade composition consisting of molecular mixtures of metallic salts which melt at predetermined temperatures. The finely ground salts are mixed with paraffin wax. Before using it is heated

gently so as to just melt the wax and reduce it to the consistency of thick paint, so it can then be streaked or painted on the work in the cold, or, as in the present case, the work is covered with a thin film of paste by dipping in the paste while the work is at a temperature above the melting point of the salts. When the wax carrying the Sentinel powder burns off, it leaves behind a layer of white salt, and upon the desired temperature being attained, the salt fuses and disappears, or, on a reduction of temperature the paste reappears as a white coating. After the bit is put in the furnace and the white residue melts instantly, plunge the bit into cold water to about ¼ to ½ in.

All bits in these tests were plunged into water as described above and slowly moved about in the water until fairly cool; then the steel was left in water until cold.

EXPERIMENTS WITH DOWN HOLES

The first series of tests was made in down holes. The purpose of these tests was to ascertain the effect of gage or diameter of bit on cutting speed. It was necessary to find this relation in order to compare different bits by reducing them to the same gage.

All tests were made in shallow holes, about 1 ft. in depth, so that the cuttings could be easily blown from the hole. Down-hole tests were made only with the 4-point bit and at a pressure of 95 lb. In most cases, five 1-minute runs were made with a bit. About 30 tests were made altogether.

A curve was plotted assuming that the cutting speed varies inversely as the square of the diameter. The first point on the theoretic curve was taken at gage 1.3 and speed 4.3, and the curve plotted accordingly. The results of the second test were then plotted in the same scale, the points falling close to the curve. The second tests was taken as being the most representative. Points plotted from the third and fourth tests fell close to a similar curve. In order to compare cutting speed of different gages, every condition, including depth of hole, etc., must be uniform, and it would not be fair to compare the speed of a new bit with the speed of the same bit when run to a smaller gage. From this curve it is evident that for small gages the cutting speed varies inversely as the square of the diameter of the bit. For large gages the results do not seem to check so well, and from results obtained in former work by H. Vogel, the relation of the 3/2 power was obtained, which may apply to larger gages.

RESULTS FROM UP HOLES

Three different pressures were used in drilling the up holes, 95 lb., 85 lb. and 70 lb. Most of the tests were made at the 95-lb. pressure. Nearly 200 different tests were made in all.

All holes were first collared to about ½ in. depth; the bit to be tested was then run at a low pressure for about 6 seconds. The bit was then taken out, the gage and the depth of hole measured, and the test was ready to start. One-minute runs by stop watch were made. All bits were run for four 1-minute tests and in a few cases six or eight 1-minute runs were made. No attempt was made to run each bit to its full extent, although in most cases at the end of four runs the cutting speed had materially diminished. The bits, however, probably would have drilled several inches farther, and in the case of the Carr bit, considerably farther. The life of bits seems to be the same at all pressures. That is, they will drill a certain distance and no more, no matter what the pressure is.

Table I represents the summary of average results and also the same average reduced, for the purpose of comparison, to uniform diameters by assuming that the cutting speed varies inversely as the square of the diameter.

It will be seen from these results that the comparative cutting speeds of the different bits at this pressure are as follows:

(1) 4-point (gage 1.75) ....2.51 in. per min.
(2) 6-point (gage 1.75) ....2.06 in. per min.
(2) Carr (gage 1.75) .....2.44 in. per min.
(3) Z (gage 1.75) ....2.13 in. per min.

At this pressure the 4-point bit cuts slightly faster than the Carr. It was very difficult to make the Z bit hold up at all on the high pressure, as the corners would invariably chip off.

Table II shows the final average of the results reduced to the three different gages by the square of diameter.

THEORY OF DRILLING ROCK

According to B. F. Tillson, "when rock is excavated by the drill bit three applications of forces seem to be involved—by abrasion, by crushing, and by severing or chipping. Although all of these must take place to a certain degree, the greatest amount of useful work is performed when the percentage of force applied to chip reaches a maximum."

TABLE I

Reduced to uniform diameters, assuming speed varies $\frac{1}{D^2}$

Kind of Bit	Reduced Gage, Inches	Average Speed Per Min., 95 Lb. P.	Average Speed Per Min., 85 Lb. P.	Average Speed Per Min., 70 Lb. P.
4-point	2.00	1.92	1.39	0.85
6-point	2.00	1.59	1.23	0.68
Carr	2.00	1.87	1.56	1.16
Z	2.00	1.63	1.51	1.16
Z flat angle	2.00	....	1.54	
4-point 5° taper	2.00	....	1.39	
4-point	1.75	2.51	1.81	1.11
6-point	1.75	2.06	1.61	0.88
Carr	1.75	2.44	2.03	1.51
Z	1.75	2.13	1.97	1.51
Z flat angle	1.75	....	2.01	
4-point 5° taper	1.75	....	1.81	
4-point	1.50	3.41	2.47	1.51
6-point	1.50	2.82	2.19	1.20
Carr	1.50	3.32	2.77	2.06
Z	1.50	2.90	2.69	2.06
Z flat angle	1.50	....	2.74	
4-point 5° taper	1.50	....	2.47	

According to this theory, the screen analysis of cutting ought to show the most efficient bit. Samples were taken from the up holes when drilling at 95 lb. pressure, from which the screen analyses were made. Screening was done in Tyler Ro-Tap apparatus. The samples were taken near the first part of a run with each bit. Some of the dust was lost in taking the sample, but as much as possible of the entire sample was saved.

The 6-point bit produced the finest cuttings, the Z bit the next finest, the Carr next and the 4-point the coarsest. This corresponds to the relative cutting speeds, the 6-point slowest, the Z next, the Carr next and 4-point fastest. In order to study further the cutting action of the different bits, four shallow holes about 1 in. deep were drilled beside each other under the same conditions and using 85 lb. pressure.[4]

A study of the bottoms of the holes revealed the fact that the 6-point hole was perfectly smooth, the 4-point nearly as smooth, the Z bit and Carr bit holes were quite rough, the Carr bit having a conical shaped projection in the center due to the large hole in the bit. The relative cutting speeds at 85 lb. pressure were as follows: 6-point, 4-point, Z and Carr, which corresponded with the apparent roughness of the bottoms of the holes.

The use of the large hole in the center of Carr bit is evidently one of its advantages and the same idea could be applied to advantage on all other bits. The advantage of the large hole is that it leaves a center core and diminishes the cutting surface.

CONCLUSIONS: COMPARATIVE MERITS OF EACH TYPE OF BIT.

Cutting Speeds.

	95 lb.	85 lb.	70 lb.
(1)....	4-point	Carr	Z bit
(2)....	Carr	Z	Carr
(3)....	Z	4-point	4-point
(4)....	6-point	6-point	6-point

From the above comparison, the 6-point bit is evidently slower drilling under all conditions. The 4-point, although ranking first at 95 lb. pressure, under ordinary conditions would drill less rapidly than either the Carr or Z. In comparison with the others, the Z bit apparently increases in cutting speed as the pressure is decreased. This would indicate that the Z bit would be quite efficient in soft

TABLE II

Reduced to uniform gages, assuming speed varies as $\frac{1}{D^2}$

	Kind of Bit	Average Diam., Inches	Average Dist. Drilled	Average Speed Per Min.	Average Initial Speed	Average Final Speed	Average Loss in Gage Per Inch
A	4-point starter	1.880	8.85	2.212	2.500	1.962	0.0110
B	4-point second	1.652	11.50	2.865	3.683	2.100	0.0108
C	4-point third	1.385	15.41	3.853	4.800	3.062	0.0068
	Reduced to uniform diameter						
	From A	1.750	....	2.554			
	From B	1.750	....	2.552			
	From C	1.750	....	2.415			
		1.750	....	2.507	Average of 4-point		
A	6-point starter	1.869	7.36	1.852	2.200	1.537	0.0189
B	6-point second	1.662	10.07	2.519	2.812	2.175	0.0109
C	6-point third	1.426	10.85	2.713	3.112	2.200	0.0068
	Reduced to uniform diameter						
	From A	1.750	....	2.112			
	From B	1.750	....	2.271			
	From C	1.750	....	1.802			
		1.750	....	2.062	Average of 6-point		
A	Carr bit second	1.535	12.42	3.109	4.025	2.775	0.0028
B	Carr bit third	1.605	13.37	3.345	3.500	2.875	0.0032
	Reduced to uniform diameter						
	From A	1.750	....	2.394			
	From B	1.750	....	2.488			
		1.750	....	2.441	Average Carr bit		
A	Z bit second	1.609	9.72	2.429	3.275	1.925	0.0104
B	Z bit third	1.447	12.87	3.212	3.850	2.600	0.0049
	Reduced to uniform diameter						
	From A	1.750	....	2.053			
	From B	1.750	....	2.196			
		1.750	....	2.130	Average Z bit		

rock or at lower pressures, but it is evidently not adapted to extreme high pressures in hard rock. From the standpoint of cutting speed, the Carr and Z bits are the most efficient.

LOSS OF GAGE

The average loss in gage per inch was as follows:

4-point	seconds	0.010
4-point	thirds	0.007
6-point	seconds	0.010
6-point	thirds	0.007
Z bit	thirds	0.004
Carr bit	seconds	0.003
Carr bit	thirds	0.003
4-point	5° taper thirds	0.004
Z bit	filed	0.003

This loss is almost constant at all pressures. It will be seen from these figures that the loss in gage with 4 and 6-point bits is considerably more than with Z or Carr bits, and that the 5° taper on a 4-point bit greatly diminishes the loss of gage.

From the standpoint of loss of gage, the Carr, Z bit and 4-point bit with a 5° taper, are superior to others. This factor is one that is often overlooked, and the great advantage of using a bit that loses little in gage is not generally considered. As an example the following calculation has been made:

DRILLING TIME

Drilling time for 6-ft. hole in granite, 1½-in. diameter at bottom. Length of changes, 1

TABLE III

CARR

Length of Steel	1 Ft.	2 Ft.	3 Ft.	4 Ft.	5 Ft.	6 Ft.
Gage in sixteenths	1 14/16	1 13/16	1 12/16	1 11/16	1 10/16	1 9/16
Gage in tenths	1.875	1.812	1.750	1.688	1.625	1.562
Distance per minute	1.771	1.897	2.034	2.186	2.352	2.554
Minutes for each foot	7.340	6.270	5.890	5.490	5.102	4.700

Time 34 min. 49 sec. for 6 ft.

Z BIT

Gage	1.875	1.812	1.750	1.688	1.625	1.562
Distance per minute	1.723	1.839	1.978	2.126	2.295	2.484
Minutes for each foot	6.960	6.530	6.070	5.640	5.230	

Time 35 min. 16 sec. for 6 ft.

4-POINT

Gage	2 1/4	2 1/8	2	1 7/8	1 6/8	1 5/8
Distance per minute	1.009	1.230	1.389	1.580	1.814	2.104
Minutes per foot	11.890	9.760	8.640	7.590	6.620	5.700

Time 50 min. 12 sec.

6-POINT

Gage	2 1/4	2 1/8	2	1 7/8	1 6/8	1 5/8
Distance per minute	0.976	1.092	1.235	1.405	1.613	1.867
Minutes per foot	12.295	11.000	9.700	8.540	7.440	6.430

Time 55 min. 24 sec. 6-ft. hole.

ft. Difference in gages, 1/16 in. with Carr and Z bits, 1/8 in. with 4-point and 6-point bits.

From these calculations the Carr and Z bits apparently save one-third in drilling time over the 4 and 6-point bits. This is due more to the fact that smaller gages can be used than to greater cutting speed. The calculations were based on actual cutting speeds and loss in gage shown in tests.

BREAKAGE AND EASE OF SHARPENING

There is little difference between the 4-point and 6-point bits in respect to ease of sharpening and tempering.

The Z bit is more easily made, but it is very difficult to temper so that it will stand up under high pressure. This is on account of the weakness of the outer cutting edges.

The Carr bit is by far the easiest of all to make and temper and can be tempered much harder than others.

SUMMARY

The results in down holes indicate that the cutting speed varies inversely as the square of the diameter, at least for smaller gages.

Drilling speed increases almost uniformly with increase in pressure. A pressure of about 85 lb. per square inch seems to be best adapted to all bits for drilling in rock of the hardness of that used in the tests.

Speed of drilling seems to be proportional to the coarseness of the cuttings as shown by screen analysis and study of the bottoms of the drill holes.

Taking into consideration its cutting qualities, loss in gage, ease of making and tempering, the Carr bit seems to be far superior to all others, except possibly the Z when used at low pressures.

The Z bit at low pressures and probably in soft rock would equal if not surpass the Carr bit in cutting speed, but on account of the difficulty in its making and tempering, it is doubtful whether it would be as desirable under any conditions as the Carr.

For exceedingly high pressures in very

hard rock, the 4-point bit made with a 5° taper on the wings seems to be superior to all others.

The 6-point bit apparently has little to recommend it under any circumstances, although it is convenient to use in starting holes.

DRYING MONEY

BY H. C. RUSSELL*

This paper is a brief description of the apparatus and methods used in the drying of paper currency at the Bureau of Engraving and Printing at Washington, D. C. It is with the drying of the paper on which the currency is printed that this paper deals.

The work at the Bureau is printed on comparatively small sheets, viz: 8¼ × 13½ in. for currency and 18½ × 20¾ in. for stamps. Experience had developed a system which was perhaps unique, and which gave good results, but entailed inconveniences and discomforts.

When the new building for the Bureau was designed it was decided to have a drying room contiguous to each press room, which thus called for seven drying rooms. It was also decided to still further divide the work of drying by the use of separate closed boxes or cabinets, each to be well insulated to reduce the heating up of dry rooms in the summer. Each of these cabinets was fitted with individual steam coils, and fans heating and forcing the air through the boxes, and, as they were to be closed, a system of exhaust ducts was necessary to allow the escape of the moist air. The fans are motor driven and placed each on its own box and taking its supply from the main room, fresh air coming into the main rooms through grated transons to take its place.

Experiments to determine the size of the boxes, the amount of air necessary and its distribution, and the heating surface required, resulted in the construction of 264 boxes as here illustrated. They are essentially closets constructed of galvanized iron, insulated with 1½ in. of hair felt, the joints riveted and bolted and made tight with wood felt. They are without bottoms and are bolted to the composition floors, the joints being made with

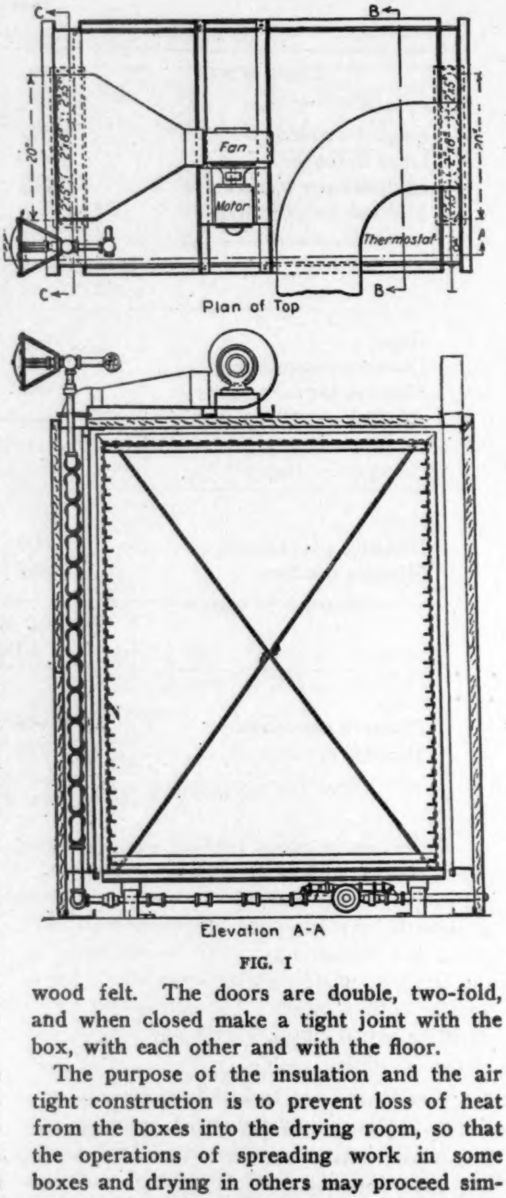


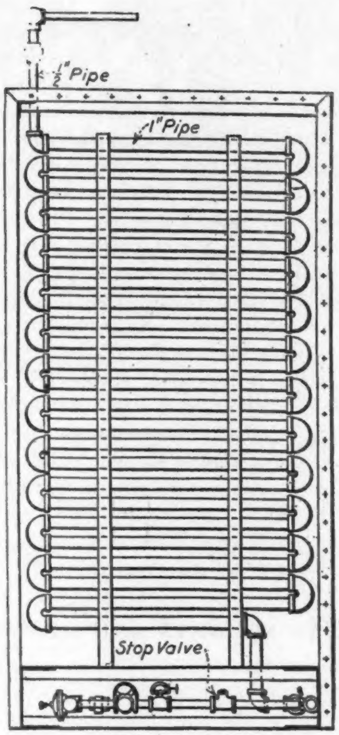
FIG. I

wood felt. The doors are double, two-fold, and when closed make a tight joint with the box, with each other and with the floor.

The purpose of the insulation and the air tight construction is to prevent loss of heat from the boxes into the drying room, so that the operations of spreading work in some boxes and drying in others may proceed simultaneously without discomfort to the attendants, who are compelled to stay in the drying room while work is being spread. Some heat is necessarily radiated into the rooms, but only a small amount of the moisture laden air escapes into the rooms; a portion of the radiated heat, however, is returned to the boxes through the air supply drawn from the room.

It will be seen from Figs. 1 and 2, that the

*From a paper at the summer meeting of the American Society of Heating and Ventilating Engineers, Chicago, July, 1917.



Elevation C-C

FIG. 2

fans deliver the air into the top of the box, whence it is forced downward over the coil surface and is delivered from the heating chamber into an equalizing air space, thence through a perforated diaphragm into the drying chamber, the perforations being so arranged that the air passes over and under the work in the trays. The condensation from the steam coil passes through another coil laid on the floor and is delivered through a thermastatic trap to a common condensation return main.

The trays are supported on a car or truck so that if for any reason a given box cannot be heated or fails to act, the work therein may be readily transferred to another spare box.

One of the principal advantages of the new system is that any desired temperature may be maintained in any individual box, and when the work in that box is dry the heat can be cut off without affecting other boxes. After the heat is cut off, the fans can be kept running long enough to reduce the temperature of the box to a comfortable temperature before the attendants need to enter the box. This cooling also has the effect of seasoning the paper, reducing the brittleness which is sometimes the effect of too rapid drying.

The air supply to each box is approximately 120 cu. ft. per min. According to the temperature and humidity of the air supplied to the coils, the condensation amounts to from 10 to 12 lbs. per hour for each box. The dry rooms, which adjoin the main press rooms, were designed to hold a total of 336 boxes, of which 264 were installed, leaving a slight margin for growth.

DRILL HOLES AND BLASTING CHARGES

In the rock excavation in connection with the widening of the Louisville & Portland Canal at Louisville, Ky., the proper spacing for drill holes was determined largely by trial. At first, holes were drilled at corners of 10-ft. squares, but later the dimensions of the squares was reduced to 7 ft. Even then, some pieces of the disrupted limestone were too large for the shovel dipper, and an additional hole was drilled at the intersection of the diagonals of each square and sometimes several small air-drilled holes were made through the limestone. These small holes were made by small motor-driven compressed air drills. The amount, distribution and strength of the blasting charge was determined by trial. Experiments were made, using dynamite varying in strength from 40 per cent. to 75 per cent., and concentrating the dynamite charge near the bottom of the holes, at top and bottom of holes and uniformly distributing the charge throughout the holes. The best results were obtained with the holes spaced 7 ft. in both directions and with a charge of 75 per cent. dynamite concentrated in equal amounts near the top and bottom of holes. The drill holes were carried 18 in. below grade, but in spite of this it was occasionally necessary to redrill the bed rock after blasting. With this method of drilling and charging, the amount of dynamite used, per cubic yard of rock, averaged 0.4 lb. The number of holes exploded at one blast was limited to from 10 to 15, because of complaints made by residents adjacent to the work claiming annoyance and damage from flying rock fragments.—*Engineering and Contracting.*

COAL WORKINGS TO PAY THE COST OF A BIG TUNNEL

At a recent meeting of the Mining Institute of Scotland it was proposed that a tunnel for goods and passenger traffic should be constructed under the Firth of Firth, paralleling and supplementing the well known Firth railway bridge. It did not appear that the enterprise if conducted in the usual way could be a paying proposition, but in the construction of the tunnel advantage could be taken of the special local conditions.

It appears that the work could largely be done as a coal mining operation. For a number of years miners on both sides of the Firth have been working the same seams of coal. In each case the excavations are going under the water, and as at this point the estuary is only two miles wide it would be only a question of time, under proper direction, when the two sets of miners would meet. It is computed that the work could be carried on profitably, and that the coal would more than pay for labor, materials and supervision.

QUARRYING COMPANIES IN THE BRITISH ARMY

The Director-General of Military Railways of Great Britain has recently issued a statement that it is proposed to raise ten quarrying companies for work in France in addition to those already in service there. The number of men required per company and the rate of pay are as follows: Eight foremen, ranking as corporals; pay per day, $0.87½ to $1.12½. Skilled quarrymen, 217, ranking as sappers; per day, $0.55 to $0.80. Engine drivers, 20, ranking as sappers; per day $0.55 to $0.80. The men should not be more than 50 years of age, and they will be engaged in quarrying roadstone in quarries which are situated well outside the danger zone. The men will be enlisted for the duration of the war, posted to the Corps of Royal Engineers, will not be armed, and their families will be entitled to the usual separation allowance.

VACCINE FOR PNEUMONIA

Among natives employed in the South African mines during the last seven years, there were over 50,000 cases of pneumonia resulting in 12,721 deaths, and the loss of over 1,000,000 working shifts. Dr. Lister, of the South African Medical Research Institute, has shown that there are several varieties of pneumococci bacillus, which causes pneumonia, and that a vaccine can be prepared which will immunise against attacks of the particular type of pneumoccocus contained in the vaccine. As the result, the Institute is now making vaccine which appears to render natives immune from infection by three strains of pneumococci, which are responsible for most of the cases of pneumonia among mine natives. Systematic tests are being carried out at the Premier diamond mine, at De Beers mine, Kimberley, and on the Crown Mines property, with distinctly promising results. The members of the Native Contingent sent to France were all inoculated with the South African Medical Research Institute vaccine, and it is said they were singularly free from pneumonia, in spite of the severity of the past winter.

RUSSIAN WEIGHTS AND MEASURES

The following table of Russian weights and measures, from an English source, will be useful in view of the big trading possibilities after the war: 1 arshine is the English equivalent of 28 in.; 3 arshines, 1 sajene, 7 ft.; 500 sajenes, 1 verst, 3,500 ft., equals 0.6628 mile; 1.508 versts, 1 English mile. Gravel measure: 1 cubic sajene in the solid, 12.7037 cubic yards; 1 doli, 0.0014 oz. troy; 96 dolis, 1 zolotnik, 2.743 dwt. troy, 0.137 oz. troy; 96 zolotniks, 1 funt, 0.903 lb. avoir., 13.166 oz. troy; 40 funts, 1 pool, 36.11 lb. avoir., 526.64 oz. troy; 100 poods, 3,611.3 lb. avoir., 52,664.5 oz, troy; 55.38 poods, 1 ton of 2,000 lb.; 62.02 poods, 1 ton of 2,240 lb.; 2,481 funts, 1 ton of 2,240 lb.; 1 zolotnik fine gold, 5.51 roubles; 1 pood fine gold, 21.160 roubles; 1 pood Lenskoie glod (average fineness), £2,001.232, equals Rs. 18,911.64; 1 zolotnik fine gold, 4.27 grams.; 1 milligram gold, Rs. 0.00129; 1 zolotnik per 100 poods, equals 2,591 dwt. per cubic yard; 1 zolotnik per cubic sajene, equals 0.216 dwt. per cubic yard; 1 oz. troy equals 7.281 zolotniks, which, at Rs. 4.92 per zolotnik at 9.45 exchange, equals £3 16s.

Statistics show that there are fewer suicides among miners than among any other class of workers.

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EVERYTHING PNEUMATIC

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CONTENTS

THE NAVAL CONSULTING BOARD ON THE SUBMARINE

The following is a brief abstract of a Bulletin recently put out by the Naval Consulting Board of the United States and entitled "The Submarine and Kindred Problems."

The general hopelessness of employing magnetic devices for deflecting the torpedo is briefly stated, and nothing employing electricity as a principal feature should be thought of except by specialists most thoroughly informed and experienced.

What may be called the habits of the submarine are outlined as follows:

Submarines must get within close range of the victim vessel, and the arming of the latter demands for it practical invisibility.

Submarines wait for long periods in expectation of striking vessels previously determined on. They can lie at rest on the bottom if the water is less than 200 feet deep, with listening and other devices to keep them informed, and they can rise for quick observation and action if promising success.

The submarine in deep water must be kept in constant motion to maintain submergence and direction, though the speed need not exceed 4 or 5 miles an hour.

Submarines of the latest type have a surface speed of at least 17 knots and a submerged speed of probably less than 10. They probably have a total radius of action of 8,000 miles at moderate cruising speed and may remain away from any base or source of supply for a month. They may have three periscopes, two conning towers and two rapid fire guns. Gyroscopic compasses, unaffected by magnetic or other extraneous influences are used for steering.

Ready and accurate gun fire from a merchantman properly equipped makes it necessary for the submarine to take complete observations during the very brief interval occupied in coming near the surface for observation with the periscope and then immediate submergence.

If remaining near the surface, the periscope may be raised, an observation taken, and the periscope lowered again, all in 30 seconds. If the submarine is on the surface, and with hatches uncovered, from one to four minutes will be required for complete submergence.

MEANS OF DISCOVERING SUBMARINES

When the condition of sea and air are fa-

vorable a submarine is readily discernible from an aeroplane flying at sufficient height, and this has worked in the English channel and elsewhere, but the aeroplanes cannot work far out at sea without mother-ships, which are not yet provided.

Various sound recording devices, intended to locate surface vessels, submarines and even moving torpedoes are being tested.

Many optical devices are suggested, also special search lights and projectors. A moving torpedo leaves in its wake a stream of air bubbles difficult to detect in a rough sea, and these bubbles also come to the surface some appreciable time after the torpedo has passed, say 50 to 200 feet, towards its target.

The dragging of trawls or nets by special guard boats not only for locating submarines but also for floating and stationary mines has given considerable success. All the methods suggested have their limitations and inventors should apply themselves not only to the improvement of them, but also to the finding of supplementary methods and devices.

PROTECTION OF SHIPS BY NETS OR SCREENS

Many designs of such devices have been suggested, but up to the present not one has received the approval of the Navy Department or the Merchant Marine. They must be heavy, are difficult to hold in position, unmanageable in a heavy sea and interfere with the speed of the vessel and its ability to manœuver. Speed and quickness in steerage are most important protective qualities. It is noted that in no other field have so many suggestions and so many duplicate inventions been presented to the Board.

THE PROTECTION OF INVISIBILITY

The point of lookout on a submarine being close to the water, the position of a vessel at a distance can only be discovered by its smoke, so that smokeless combustion is desirable. Relative invisibility at shorter distance may also be afforded by methods of painting. The submarine has something of the advantage in the silhoueting of the object at the horizon on account of its lower point of observation. (This latter suggestion does not appear in the Bulletin).

TO DESTROY OR BLIND THE SUBMARINES

A rapid gun is effective when the submarine is seen within accurate range of the gun; but the target is so small that it is difficult to hit.

The powerful effect of any submarine explosion on all neighboring bodies provides a simple means of destroying or of crippling an under-sea boat. Once it has been even approximately located, the setting off of a heavy charge of high explosive, well submerged in the vicinity of the submarine will bring about this result. Heavy, black petroleum or similar substance upon the surface of the water, has sometimes clouded the glass of the periscope in rising out of the water so that nothing could be seen through it.

Many vessels have saved themselves from torpedo attack by a smoke screen. This may be formed by the incomplete combustion of the oil used for fuel or by burning chemicals. When enveloped in cloud the vesssel if of sufficient speed may change its direction or position with a good chance to escape.

The Bulletin gives information necessary to all would-be inventors concerning mines, floating or stationary, submarine torpedos and their manipulation.

WHY SUBMARINES CANNOT BE BLOCKADED

The submarine bases are very strongly protected by land batteries, by aeroplane observers and by large areas of thickly mined waters extending beyond the ranges of the heaviest guns. Attempts to trap the submarines going or coming are continuous, and here is presented a broad field for invention.

A GENERAL LETTER TO INVENTORS

The Naval Consulting Board is now constantly receiving so many letters of suggestions, and formal presentations of inventions of all degrees of practicability that it is found impossible to reply to them, and a formal printed letter has been prepared which covers a large number of the cases and should be satisfactory to the recipient. Perhaps the most interesting portion of this letter is the following enumeration of objections which are found to apply, one or more of them, to a large number of the propositions received.

1. It has been suggested before and, therefore, whether approved or disapproved, requires no further action.

2. A similar device is already in use by the Navy.

3. You offer a desideratum rather than an invention.

4. It is not considered practicable at present.

5. According to Naval authorities, such a device is not required.

6. Prevailing conditions render its use impossible.

7. The desired purpose is now more efficiently accomplished.

8. There is no method known at present of applying the suggestion.

9. Not practicable according to natural laws as known.

10. The facilities for construction are not available.

11. It would violate laws of war as interpreted by this country and our allies.

12. It would be too dangerous to use.

13. A similar suggestion has been tried and abandoned.

14. The proposal is not fully understood.

15. Its use would interfere with handling the ship.

16. Not practicable under marine conditions.

17. Ineffective against submarines as now built.

The purpose of the Board is distinctly to encourage rather than to discourage invention, and its purpose must be helped by these suggestions of "how not to do it."

All communications are carefully considered by a committee of six expert examiners who are all anxious to find anything that may help the cause.

"SAVING BY SCRAPPING AIR COMPRESSORS"

The following inquiry comes to us from England, "Passed by the Censor," with no hint of the address of the writer, so that we can only reply through our columns.

To the Editor of Compressed Air Magazine:

Referring to Mr. Stephen W. Symons' interesting article in your June issue, could he tell us how much the improvement was due to the new compressor and how much to the "new system of pipe lines which eliminated restricted orifices, leakages, etc." I would have scrapped the old pipe line first.

Lewis L. Kelsey.

As Mr. Symons is now serving with the British Aviation Corps it is impossible for him to reply. The problem in the above case was not to ascertain and apportion in detail the losses attributed to the compressors and to the piping system separately, both being concededly inefficient, but to replace both in the cheapest and quickest way possible. Although the old compressors were to be thrown out in any case it might have been an interesting experiment to have first reconstructed and rearranged the piping system, noting the results, but it would have taken much time, it would have entailed considerable cost, it would not have been "business."

SPECIAL AIR GIVES SPECIAL RESULTS

BY FRANK RICHARDS

[It is believed that the following, reprinted from *The Salt Lake Mining Review,* Aug. 30, 1917, is sufficiently understandable without note or comment.—Ed. C. A. M.].

"A Man Who Knows," writing in *The Salt Lake Mining Review,* July 30, uses my name at the beginning and seems to invite criticism or reply. His article, which is not long, touches the fundamental principles of air compression and seems to call for a somewhat elaborate reply which I will not attempt here. I wish now only to refer to his penultimate paragraph which it seems best to reproduce in full.

"It is a well known fact also," he says, "that the hot, *wet* air is the direct cause of the carbonization or baking of the oil in the high pressure valves, causing them to leak and very often to break. The intercooler which removes the greatest amount of water from the air before it enters the high pressure cylinder of the compressor is therefore the best one to use."

The "Man Who Knows" must certainly know, and must use in his compressors, some special brand of air which the rest of us do not know. Any air with which we are familiar, even if, as free air, it be at the saturation point with moisture, and it couldn't be wetter than that, will be *very dry air* when it is compressed to the intermediate pressure and is passed through the discharge valves of the low pressure cylinder, and of course the intercooler can have no retroactive effect up to this point.

If now this partially compressed air is passed through the most perfect intercooler in the world, which the "Man Who Knows" should know about, and if all the moisture which at this stage is possible has been taken out of it (not *all* the moisture by any means), or if the air is only passed through an ordinary intercooler such as the most experienced and successful compressor builders produce; or if, thirdly, the air is passed from the low

pressure cylinder to the high pressure cylinder without going through any intercooler at all, this air when compressed to its terminal pressure and passing through the discharge valves of the high pressure cylinder will still be very dry air, dryer than at any previous point of its passage through the machine.

All this, of course, provided it is not a special brand of air which the "Man Who Knows" may know about. If the intercooler which the "Man Who Knows" knows about can get rid of "hot wet air" in the compressor at a pressure of 80 or 100 pounds he must know how the air got wet, and this knowledge may carry with it the secret also of getting the water out.

"ADVANCED FIRST AID INSTRUCTIONS FOR MINES"

The above is the title of what must be considered a most valuable handbook, or rather pocketbook, just published by the Bureau of Mines. It is prepared by a committee of surgeons: G. H. Halberstadt, A. F. Kuoefel, W. A. Lynott, W. S. Rountree and W. J. Shields, and admirably covers a much wider field than is indicated by its title. It deals not only with the treatment of all classes of accidents and disablements that may occur, but outlines generally the structure and functions of the human body and the conditions for maintaining normal health. There are 168 pages, 5¾ by 4½ inches, copiously illustrated. The paper covered edition is for free distribution and the price of the buckram-bound edition is 35 cents.

AIR NAVIGATION IN WIND, RAIN, CLOUD AND FOG

BY W. H. DINES*

A recent lecture by Lord Montagu of Beaulieu to the Aeronautical Society has directed attention to the possibility after the war of conveying mails and passengers, and perhaps goods, from place to place, by aeroplanes. In suitable weather such transit should present no difficulty save that of expense, provided that landing places can be found in such positions that the stages may not be too long, but it is obvious that the weather is, and must remain, a very important factor for many years to come.

*From Nature.

The kinds of weather inimical to aviation are too much wind, low clouds and fog, and of these fog is perhaps the worst, as it is also in the case of shipping. The ways in which wind affects an aeroplane are various. There is the difficulty of starting and landing, but the days on which this is serious are not numerous, even in a windy country like England. But still there are days when landing is unsafe, and it is the misfortune with an aeroplane that it must in some way or other come to the earth as soon as its stock of petrol is exhausted. It cannot, like a ship outside a port with a dangerous bar, wait until conditions are more favorable; it must come down, whatever the risk. Once in the air, a steady wind has no effect upon the flying of an aeroplane, although it has a great effect upon the direction of the course. So much misapprehension exists on this point that it cannot be put too clearly. First, however, it must be stated frankly that a perfectly steady wind does not exist in practice, but the ordinary wind becomes more and more steady as the height increases, and in so far as the drift of an aeroplane is concerned it has the same effect as a steady wind of the same mean velocity.

The pilot, therefore, if the earth is hidden from him by a sheet of clouds, is absolutely and entirely ignorant of the strength and direction of the wind in which he is flying; it is just the same to him if it be a dead calm or if it be blowing at the rate of a hundred miles an hour from the east or from the west; he is, indeed, as unconscious of the motion which he is sharing with the air as he is of his daily revolution at a rate in these latitudes of some 600 miles an hour round the axis of the earth. But the effect upon the drift of his machine may be very considerable, and as he does not know what it is he cannot allow for it. The sailor also is concerned with the drift of his vessel, but he has in general a fairly good knowledge of how much it is; the currents due to the tide can be predicted, and the leeway due to wind can be estimated, but it is not so with the airman. Moreover, the rate of drift of a vessel is mostly small in comparison with her motion through the water, but in exceptional instances the velocity of the wind may equal the velocity of the aeroplane.

Thus Glasgow lies very close to a point 400

miles due north of Plymouth, and an aeroplane leaving Plymouth and flying due north at eighty miles an hour would find itself close to Glasgow in five hours' time. Should, however, a strong west wind be blowing of which the pilot did not know, and also clouds so that he could not see the earth, he would, if steering by compass, find himself in five hours' time over the North Sea, and quite possibly much nearer to the Danish than to the English coast. In the present state of our knowledge he could obtain information at starting of the general direction and strength of the wind, but not in such detail that he could hit off Glasgow within 100 or 200 miles. If he could see the ground he could ascertain that he was not traveling in the way his machine was pointing, and would thus become aware of his drift, but if he could see the ground he could steer by the known landmarks. There would be few landmarks over the sea, but the appearance of the surface should give him information as to the strength of the wind, and also of its direction.

Hence it seems likely that in countries like England, where clouds prevail, long-distance flight, if it is to be carried on at regular times day after day, will have to be at low elevations. About 3,000 feet is the usual height of the winter cloud sheet, but it may on occasion easily descend to 2,000 feet.

Wind, therefore, though when it is steady and in a favorable direction it may be of assistance for a journey in its own direction, will in general be a hindrance to aerial navigation, and when combined with low clouds may become an insuperable hindrance. In cases where its velocity and direction can be accurately foretold, the difficulty about allowing for the drift can be overcome, but such precise forecast is not yet practicable.

A gusty wind introduces difficulties of its own; the so-called holes in the air, of which one heard so much in the early days of aviation, were due to gustiness, but greater stability and speed in the machine are eliminating these difficulties.

Clouds introduce a difficulty of their own, apart from the point that has been already considered. It would seem at first sight as though a man would retain his sense of the vertical direction in any circumstances, but this is not so. Were a man placed inside a hollow vessel that was falling freely without air resistance, he would be entirely without sense of weight or direction, and the pilot of an aeroplane in an extensive mass of cloud is in much the same position. He cannot see any definite object, and apart from sight his sense of direction depends upon the reaction between him and the seat he is sitting on. So long as the motion is uniform this reaction is vertical, but any acceleration of the machine alters the direction and intensity of the reaction, and so confuses the sense of level. The same effect is produced upon a spirit-level or similar instrument, and so confusing is the effect that it is said the machine may almost be upside down without the pilot knowing it. It would seem as though a gyroscope might to some extent meet the difficulty. One result of this uncertainty of level is that astronomical observations for the determination of latitude and longitude are not possible unless the horizon can be seen, and thus the amount of the error produced by want of knowledge of the drift cannot be known.

Fog is to all intents and purposes simply a cloud touching the earth. Landing places for aviators have naturally been put in low, sheltered positions, partly because a shelter from wind is required, but probably because more or less of a dead level is necessary, and such flat places are more likely to be found at low altitudes. Such positions are especially liable to fog. The danger of a fog lies in its concealing the landing place and hiding from the pilot until the last moment his distance from the ground.

Thus it appears that the demand of the airman on the meteorologist is that he shall be able to forecast wind and fog, and, to a less extent, clouds, on the route the airman is proposing to follow. It has long been the business of the Meteorological Office to forecast wind, and a certain amount of precision has been attained. During last winter Major Taylor investigated the possibility of forecasting fog, and gave the results in lectures to the Royal Meteorological and Aeronautical Societies. His work constitutes a considerable advance investigation of this difficult subject. If we express the wind in terms of its two components, W. to E. and S.

to N., the probable error of a forecast for each component is perhaps about ten miles an hour, and there is not much prospect of improving this; the estimate is for England and the Continent, but farther south the conditions are much better.

I do not wish to emphasize the difficulties which lie in the way of regular air services, but they are there, and the first step towards overcoming them is to admit their existence.

NOTES

In 33 years the production of iron in the United States has increased 337 per cent., petroleum, 391 per cent.; copper, 1,200 per cent.; cement, 2,087 per cent.; lead, 125 per cent., and zinc, 638 per cent. During the same period, the production of coal has more than trebled.

The State Highway Department of Missouri in a recent bulletin suggests that mudholes sometimes can be remedied by drilling down 4 or 5 ft. and putting in a shot of dynamite to loosen the subsoil and provide underdrainage.

Users of fuel oil in Buenos Ayres are burning rafaelita, a dry form of petroleum found in the provinces of Patagonia, Mendoza, and Neuquen, to help meet the present shortage of that product. Of late the burning of rafaelita has increased very greatly and helps materially to lower cost of fuel charges.

According to figures recently published, some six million shells were used in the operations that resulted in the capture of Messines. Reckoning these at an average weight of slightly over 100 lb.—probably the average was higher—this would represent a consumption of about 300,000 tons of steel.

A Permanent Aircraft Exhibit is to be established in Washington in the immediate future, under the auspices of the National Advisory Committee for Aeronautics and the Aircraft Production Board. The exhibit will include all kinds of aircraft material, engine parts, sections of planes, etc., both American and foreign, and the aim will be to make it representative of the latest developments of aeronautics. The principal object of this undertaking is to familiarize American aircraft builders and engineers with the newest and best features of aircraft construction.

The Caproni triplanes now appearing in Italy are capable of carrying 25 passengers each. They already hold a number of world-records, including the useful weight carried —nearly five tons—the speed record of 157 miles per hour, and the distance record of a run of 920 miles in 10 hours without stop. They are equipped with three motors of 700 h.p. each.

Through the cooperation of manufacturers of steel plates or shapes, manufacturers of electric spot-welding apparatus, and the United States Bureau of Standards, a program for the investigation of spot-welded joints has been undertaken. This work will be done to show the practicability of substituting spot welding for riveting in the assembling of steel structures of various types.

The Denver Tramway is making use of a 50-ft. Westinghouse air compressor, mounted on skids for supplying air for track tamping. The compressor is motor driven from the trolley supply current and is of sufficient capacity to take care of four tampers at a time. The company has been using two tampers and has been able to accomplish as much work with the two men as twelve men could do with manual tamping.

In describing the work of the airmen at the front, Major L. W. B. Rees of the British flying corps, stated recently that the British fly on three levels with three kinds of machines. The lowest are the artillery directors, who circle about in big figure eights some 6,000 feet above the enemy trenches and flash back directions to the British gunners by wireless. Above them at 10,000 feet, are the heavy fighters with two men to a machine and able to keep the air for four hours at a speed of 110 miles per hour. At a height of 15,000 feet are the single-man, light fighters, capable of 130 miles an hour and of ascending the first 10,000 feet in ten minutes.

Tentative arrangements have been made for financing a new railway in Northern Peru, which, when completed, should open up one

of the richest sections of South America. The line as projected will be about 250 miles long, and will be another link in the Pan-American transcontinental system. The road will cross the lowest depression of the Andes, and on the Pacific it will have what is said to be the best seaport in South America, at Payta. Thence it will extend inland, traversing the richest regions of the Americas. The railway will put Lima, the capital of Peru, within five days of Iquitos, the head of the rubber industry of the Amazon. The trip from Lima to Iquitos cannot now be made in less than sixty days. It will put New York City within ten to eleven days of Iquitos, as compared with about thirty-five days at present.

A very remarkable trolley accident recently occurred in New Zealand on the Otira Railway tunnel, in course of construction. Four men on a trolley entered the tunnel, which has a down gradient of 1 in 33. After the party had travelled a short distance their acetylene light was extinguished, and in the darkness the trolley got out of control, and acquired a great speed. Two of the men managed to jump off before the trolley gathered way, but the two who remained were threatened with certain death. The pumps in the tunnel, however, were not working, and the end formed a "pocket" filled with water. This acted as a buffer when the trolley dashed into it. The two men were thrown into the water, where they remained shoulder deep for some time. Darkness rendered their rescue difficult, but it was safely accomplished. They were much exhausted, but unhurt.

What is claimed as the tallest chimney in the world was recently completed for a copper smelter at Sagonoseki, Japan. It is constructed of concrete, 570 ft. high, 26¼ ft. inside diameter at the top, and 42 ft. in diameter at the base. The great height was decided on to carry the fumes from the smelter to an altitude that will avoid killing the surrounding vegetation. The foundation, which is 95 ft. in diameter, contains 2,700 cub. yards of concrete. For 150 ft. the chimney is reinforced by a concrete lining, separated from the outer shell by a 5-ft. air space. The opening at the base is 31 ft. high and 20 ft. wide. The flue connecting the furnaces and chimney is 30 ft. in diameter, and 2,500 ft. long, and is provided with openings for cleaning. In the construction of the chimney 400 tons of steel was used.

According to the *Frankfurter Zeitung*, the newly manufactured compressed cellulose piping has proved very satisfactory in chemical factories and also in mining works. The new material, it is said, is absolutely non-porous, is considerably lighter than iron, can be worked like wood, and is consequently easily moved and repaired. As cellulose is a bad conductor of heat, it requires no particular protection against heat; it also resists chemical influences better than iron. Cellulose tubes are suitable for conducting hot and cold air, and for corrosive gases which eat into iron conductors very quickly. They are not suitable, however, for steam.

LATEST U. S. PATENTS

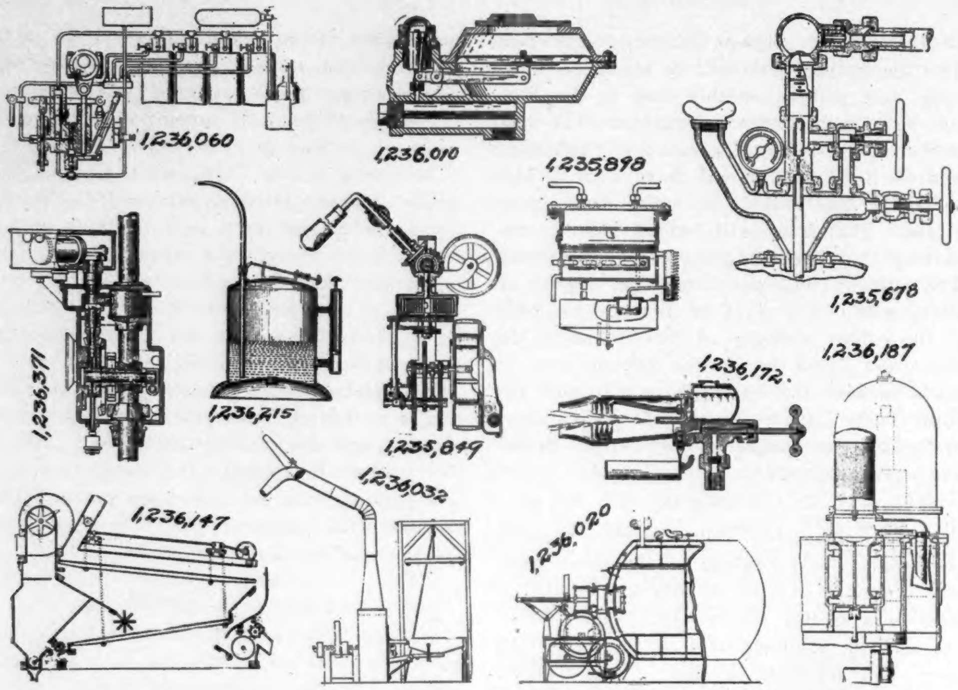
Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

AUGUST 7.

1,235,678. FUEL-OIL OUTSIDE ATOMIZER. Paul L. Geer, San Jose, Cal.
1,235,759. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. Ralph G. Benson, Chicago, Ill.
1,235,761. ELECTRIC AIR-HEATER. Carl O. Bergstrom, Boston, Mass.
1,235,849. VACUUM-CLEANER. Ezra B. Smith, Chicago, Ill.
1,235,898. DEVICE FOR WITHDRAWING AND SEPARATING THE LIQUID CONTENTS OF THE CRANK-CASE OF AN INTERNAL-COMBUSTION ENGINE. Webb Jay, Chicago, Ill.
1,236,010. HIGH PRESSURE GAS REGULATOR. G. W. Savage, Chester, Pa.
1,236,020. APPARATUS FOR GENERATING POWER. Washington B. Vanderlip, Oakland, Cal.
1,236,032. PNEUMATIC GRAIN-ELEVATOR. John R. Wright, Wheeling, Mo.
1,236,060. FUEL-SUPPLY SYSTEM FOR INTERNAL-COMBUSTION ENGINES. Gregory Caldwell Davison, New London, Conn.
1,236,147. COTTON-SEED CLEANER. James H. Cary, Memphis, Tenn.
1,236,172. BLOW-TORCH. Gustaf E. Holmgren, Duluth, Minn.
1,236,187. AIR-COMPRESSOR FOR INTERNAL-COMBUSTION ENGINES. Hermann Lemp, Erie, Pa.
1,236,215. AIR-FED OILER. Henry Schade, Shelby, Iowa.
1,236,241. APPARATUS FOR DRAWING GLASS CYLINDERS. William Westbury Okmulgee, Okla.
1,236,371. DRILLING APPARATUS. George H. Gilman, Claremont, N. H.

AUGUST 14.

1,236,413. APPARATUS FOR MILKING COWS. Henry Droutledge, Auckland, New Zealand.



PNEUMATIC PATENTS AUGUST 7

PNEUMATIC PATENTS AUGUST 14

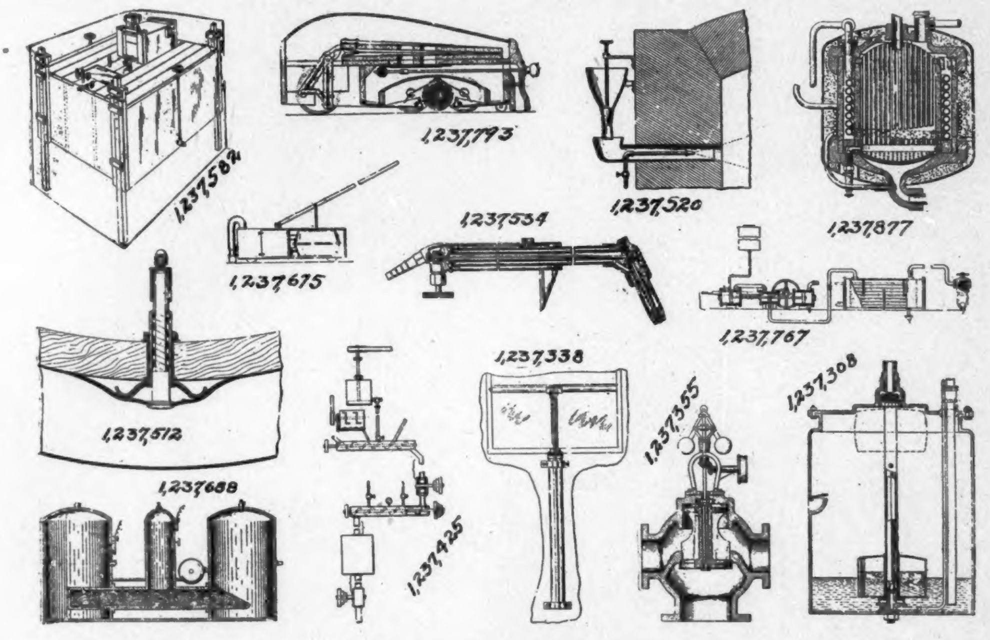
1,236,431. APPARATUS FOR MILKING CATTLE. Charles Gilbert Hawley, Chicago, Ill.
1,236,479. TIRE - PUMP. Adolph Peteler, Freeport, N. Y.
1,236,513. TIRE-PUMP. William U. Watson, Chicago, Ill.
1,236,548. APPARATUS FOR TREATING MILK. William J. Davis and Lars Johnson, Chicago, Ill.
1,236,614. EXHAUST - CONTROLLING VALVE FOR PERCUSSIVE TOOLS. Fred M. Slater, Easton, Pa.
1,236,651. PNEUMATIC PUMP. Eugene L. Arnott and John S. Arnott, Greenfield, Ohio.
1,236,663. PNEUMATIC-DESPATCH - TUBE APPARATUS. Walter Bixby, Dorchester, Mass.
1,236,701-2-3-4. PNEUMATIC TOOL. George H. Gilman, Claremont, N. H.
1,236,922. PNEUMATIC ENGINE OR MOTOR. Harry Gibbs, Higher Tranmere, England.

tungsten in said space to combine with residual gases.
1,237,212. BLOWER. Abraham L. Loewen, Hillsboro, Kans.

AUGUST 21.

1,237,308. COMPRESSED - AIR WATER-RAISING APPARATUS. Christian De Preville, Paris, France.
1,237,335. GOVERNOR-ACTUATED FLUID-CONTROLLER. Frank Hennebohle, Chicago, Ill.
1,237,338. PNEUMATICALLY - OPERATED WINDOW-CLEANER. Frederic W. Hogg, The Dalles, Oreg.
1,237,425. METHOD OF TREATING WHEAT. Arnold C. von Hagen, Kansas City, Mo.

1. The process which consists in treating grain first by subjecting the same to moisture, then agitating the grain to distribute the moisture over the shells of the grain, and



PNEUMATIC PATENTS AUGUST 21

1,236,937. METHOD OF AND MEANS FOR FORMING GLASS ARTICLES. William S. Hough, Jr., St. Catherines, Ontario, Canada.
1,236,944. VACUUM CLEANING-MACHINE. James B. Kirby, Cleveland, Ohio.
1,236,952. MILKING - MACHINE. Meredith Leitch, Poughkeepsie, N. Y.
1,236,953. AUTOMATIC REGULATOR FOR GAS SYSTEMS. Herbert F. Lewis, Philadelphia, Pa.
1,237,196. HYDRAULIC MEANS FOR COMPRESSING GASES. Kenneth Gauldie, Glasgow, Scotland.
1,237,210. METHOD OF PRODUCING VACUUMS. Irving Langusier, Schenectady, N. Y.

2. The method of producing high vacua which consists in reducing the gaseous pressure in the space to be evacuated until the atmosphere in said space has become highly attenuated and then vaporizing metallic

then by a separate operation forcing the moisture into the shell of the grain by pressure.

1,237,512. PNEUMATIC-TIRE PRESSURE-GAGE. Charles Harrison and Kenneth Lamond, Vancouver, British Columbia, Canada.
1,237,520. METHOD AND MEANS FOR COATING KILN-BAKED ARTICLES. John W. Ivery, Brazil, Ind.

1. The method of coating kiln-baked articles during the baking operation, consisting in inducing a current of atmospheric air through a passage by a fluid pressure blast and blowing said air into the upper portion of the kiln by such blast, and in introducing the glazing material into said passage, whereby free mixing of said material with the currents passing through the passage is effected, and whereby said currents will discharge said material into the kiln in the form of a cloud.

1,237,534-5. CUTTING OR WELDING BLOWPIPE. Edgar C. Martin, Central, S. C.

1,237,582. APPARATUS UTILIZED IN SUB-AQUEOUS BUILDING CONSTRUCTION. John Taylor, Hamilton, Ontario, Canada.

1. A device of the class described comprising a working chamber open at the bottom and adapted to be lowered over sub-aqueous construction, ballast tanks mounted on the working chamber and open to the atmosphere on the top, and means for alternately filling and emptying the tanks with water ballast without the use of pumps.

1,237,675. SUCTION CLEANING - MACHINE. David P. Moore and Samuel B. Pack, Washington, D. C.

1,237,688. EXPLOSIVE METHOD OF GENERATING POWER. Pontus Ostenberg, Los Gatos, Cal.

1,237,767. PROCESS OF PURIFYING GAS. Willard O. Felt, Brooklyn, N. Y.

1. A process of the nature disclosed, which comprises compressing to a pressure of approximately 300 pounds per square inch a fluid mixture comprising a gas, mixing said mixture with glycerin while under compression, and reducing the temperature of the resultant mixture to approximately 60

AUGUST 28.

1,238,101. PROCESS OF MAKING PLASTIC LUBRICATING COMPOUNDS. Eli F. Burch, Laurel Springs, N. J.

1. The process of preparing a lubricant, which consists in mixing an asphaltic oil and a paraffin oil, the latter having approximately the physical properties of dodecane, then heating the mixture to a temperature of approximately 400 degrees F. to 450 degrees F and blowing through the heated mixture.

1,238,238. NUT-CRACKING MACHINE. Dick B. Williams, New Orleans, La.

6. A nut cracking machine including shell cracking mechanism, and an air blast ejector device having an intermittently-operative blast and a constantly-operative blast.

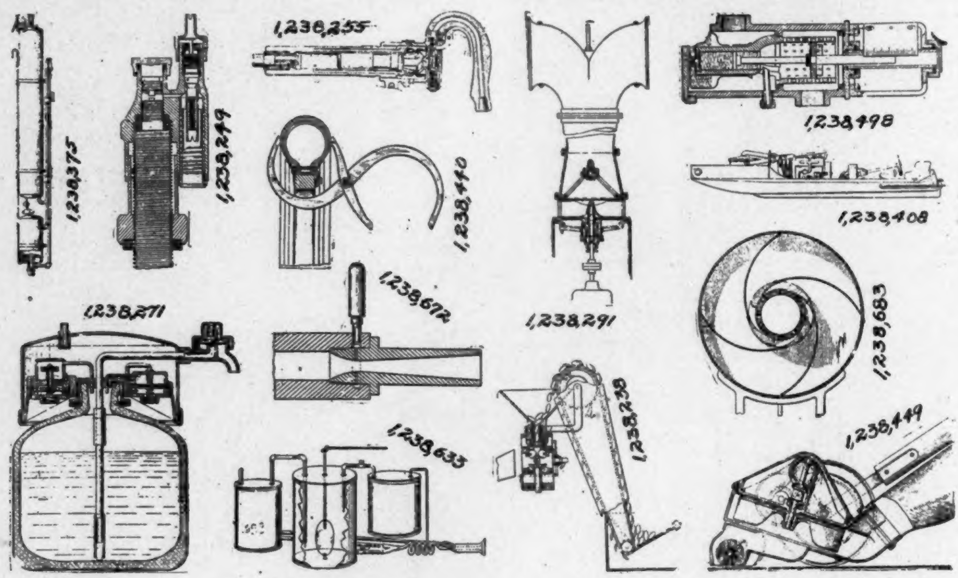
1,138,249. AIR-PRESSURE GAGE. Sherman S. Benson, York, Nebr.

1,238,255. OPEN GRIP-HANDLE, INSIDE-TRIGGER PNEUMATIC TOOL. Mathew J. Burkel, Aurora, Ill.

1,238,271. SIPHON-HEAD. Paul Crovo, Carlstadt, N. J.

1,238,291. SIREN. Harry C. Heath, San Francisco, Cal.

1,238,375. AIR-BRAKE ATTACHMENT. Abbott L. Wright, Chicago, Ill.



PNEUMATIC PATENTS AUGUST 28

degrees F. while under compression, thereby separating glycerin and contained impurities and liberating the gas in a relatively purified condition.

1,237,793. SUCTION - SWEEPER. Edward Krantz, Chicago, Ill.

1,237,877. GENERATION OF PRESSURE. Josiah Dow, Philadelphia, Pa.

1. As an improvement in the art of generating pressure from a combustible fluid, the mode herein described which consists in delivering to a combustion chamber under pressure a mixture of combustible fluid and air, directing the products of combustion first forwardly, then rearwardly, and then again forwardly, and during their second forward excursion subjecting them to the action of the products of combustion during their first forward excursion, and adding water to the products of combustion at an intermediate stage of their travel.

1,238,408. PNEUMATICALLY - PROPELLED HYDRO-PLANE. Ray E. Kellogg, Los Angeles, Cal.

1,238,440. PNEUMATIC - TIRE CALIPERS. Albert O. Running, Hawkins, Wis.

1,238,449. SUCTION-CLEANER. William E. Sherbondy, Cleveland, Ohio.

1,238,498. FLUID-METER. Clarence A. Dawley, Plainfield, N. J.

1,238,633. FUEL-FEEDING SYSTEM. Frank Caldwell, Cincinnati, Ohio.

4. In an apparatus of the character described, the combination of means for churning air and oil, independent pipes for supplying air under pressure, means for mixing the churned air and oil with the air from one of said supply pipes, and a discharging element having means for delivering the mixture with the air from the other supply pipe.

1,238,672. FLUID - PRESSURE NOZZLE. John M. Hopwood, Pittsburgh, Pa.